Concurrent evaluation of renewable energy technology schemes in Northeastern states under NEC Plan

Prepared for North Eastern Council (NEC), Shillong

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Contents

Note: Each chapter present information under the following heads.

- Implementation
- Functional status

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Executive Summary

The renewable energy programme in the North Eastern region was initiated in the early eighties, with initial emphasis on biogas technology Subsequently, over the years various technologies ranging from improved cookstoves and biogas plants to wind energy generators and micro-hydel systems were disseminated under this initiative The North Eastern Council (NEC) under its Renewable Resources of Energy (RRE) division, is also involved in the implementation of renewable energy schemes since the early eighties through the respective state government departments as well as NGOs in the region

The present study is an attempt to consolidate information on the performance of various renewable energy schemes implemented under the NEC's RRE programme in all the seven states of the region The study is a corollary to the recommendation made in TERI's earlier evaluation study of NEC's schemes for concurrent evaluation of the schemes currently under implementation Thus a technical performance evaluation of RETs disseminated under the NEC plan was conducted in two phases. Phase I included the schemes sanctioned between 1990 and 1995, and Phase II covered those sanctioned during 1995 to 1998 The present study is a consolidated report for Phase I and Phase II schemes evaluated

The objective of this study was to evaluate all RET systems installed under NEC's RRE programme in all the states of the region The devices evaluated includes solar lantern, solar domestic lights, solar streetlights, power plant, solar pump, solar water heater, water mills, micro hydro systems, biogas plants, improved cookstoves, energy parks, exhibition vans etc Out of 60 schemes provided for evaluation, 57 were physically verified for their technical performance and the scope for rectification Fifty three per cent of the devices/systems evaluated were found to be functional, and about 2 % are yet to be commissioned by the implementing agencies at the time of evaluation Among all the technologies disseminated in the region, solar photovoltaic has been found to have comparatively better functionality rate with about 52% of the evaluated systems being functional. In case of solar thermal systems, the functionality rate is only 35% and only about 21% of the micro hydro systems were found to be functional Not a single improved chulha out of the total 667 evaluated were found to be in use In spite of the overall low functional status of the schemes implemented, there is scope to revive selected non-functional systems as information on the nature of the defects has been collected during the evaluation process. Given the considerable investment made in executing the schemes, it would be a worthwhile exercise to undertake rectification measures so as to revitalize the damaged devices. It is suggested that NEC could invite the implementing agencies for a discussion on the functional status of the schemes and the lessons learnt for effective dissemination in their future programmes

ASSAM

S N	Name of the Scheme	Reference sanction No Date	Location	Type and no of system	No of system evaluated	Status	Phase and year of evaluation	Reference page no
1	SPV Electrification of 9 vilages in Kamrup district	NEC(FIN)/1-33/93-94/261 31/03/1994	Nartap, Sonapur Kamrup district	Solar DLS 378 nos Solar lantern 18 Solar TV/VCP 11 Solar pump & Still 5	All	Functional 346 Non functional 66	Dec-98 Phase 1	22
2	Electrification of Tarabari village in Kamrup district	NEC(FIN)1-25/92-93/99 16/03/1993	Tarabari village Kamrup district	Solar lanterns 160 Solar DLS 4 Solar Street light 8 Improved chulha 80 Others 19	All	All non functional	Jan-99 Phase 1	24,58, 66
3	SPV devices in 20 remote hospitals in Assam	NEC/RRE/283/97-98/55 27/03/98	Yet to be selected	Details not available		Yet to be implemented by ASTEC	Mar-01 Phase 2	26
4	Setting up of RRE Equipment in NERIWALM Camp	NEC(FIN)/1-33/93-94/174 23/02/1994	Tezpur	Solar systems 23 Biomass systems 5 Wind Mill 1	All	All functional	Jul-98 Phase 1	75
5	Setting up of energy park in Assam	NEC(FIN)/1-33/91-92/377 24/03/1992	Guwahati	Solar systems 10 Biomass systems 14 Wind Mill 2	All	Yet to be commissioned by ASTEC	Jul-98 Phase 1	77
6	*Mobile Exhibition Van*	NEC(FIN)/1-33/94-95/95 09/11/94	Guwahati	Solar systems 8 Biomass systems 3 Wind Mill 1	All	All functional	Jul-98 Phase 1	78
7	RRE demonstartion in 28 school science centres	NEC/RRE/282/97-98/54 27/03/98	Yet to be selected	Details not available		Yet to be implemented by ASTE Council	Mar-01 Phase 2	78

MANIPUR

S N	Name of the Scheme	Reference sanction No Date	Location	Type and no of system	No of system evaluated	Status	Phase and year of evaluation	Referenc page no
1	Electrification of 4 villages by SPV System	NEC(FIN)1-33/87-88/321 16/03/1988	Ukhrul, Senapati & Tamenglong dists	SPV Street lights 38 SPV domestic lights 60	All	All non functional	Mar-99 Phase 1	27
2	Wind-cum solar energy power supply at Kongkanthana village	NEC(FIN)/1-25/88-89/16 14/03/1989	Kamjon block Ukhrul district	SPV & aerogenerator 1	1	Non functional	Mar-99 Phase 1	28
3	1000LPD solar hot water System at R M C Imphal	NEC (FIN)/1-25/84-85/67 23/01/1985	Imphal	Solar water heater 1	1	Non functional	Mar-99 Phase 1	44
4	Solar thermal system in Manipur	NEC(FIN)/1-25/88-89/16 14/03/1989	Institutions in diff districts & Imphal	Solar water heater 13 1000 LPD each system	13	2 functional 11 non functional	Mar-99 Phase1	44
5	Scheme for cooking energy need in Manipur	NEC(FIN)/1-25/88-89/16 14/03/1989	Chandel, Ukhrul, Ccpur Tam'glong	Improved chulha 537 Energy plantation 3 site	537 2 sites	Non functional 1 site successful	Mar-99 Phase1	67
6	Construction cum-training course on biogas plant in Manipur	NEC(FIN)/1-25/88-89/16 14/03/1989	Iroisemba village Imphal	Biogas plant 1	1	Non functional	Mar-99 Phase1	67
7	Research and Development Project on Energy Efficient	NEC(FIN)/1-25/88-89/16 14/03/1989	Molnom, Molbung, Haotah, Thingkangphai	Improved chulha 250	50	Non functional 50	Mar-99 Phase1	68

MEGHALAYA

S N	Name of the Scheme	Reference sanction No Date	Location	Type and no of system	No of system evaluated	Status	Phase and year of evaluation	Reference page no
1	Electrification of Rambigiri village	NEC(FIN)/1-25/95-96/27 20/10/1995	East Garo hills district	Solar lantern 18 Street lights 5	All	All non functional	Aug-98 Phase 1	29
2	2 5 kw Solar P V Plant (excluding solar panel)	NEC(FIN)/1-25/89-90/10 27/10/1989	Maullien village Jaintiya hills district	1 no 2 5 kW plant	1	Non functional	Nov-98 Phase 1	29
3	Electrification of two Villages in Meghalaya	NEC/RRE/282/97-98/63 27/3/98	Belguri, West Garo hil Nongpyrdi East Khasi hills	2 nos 2 kW plant	2	Functional	Jan-00 Phase 2	30
4	Solar energy in Umdang Village	NEC(FIN)/1-25/92-93/98 10/03/1993	West Khasi hills district	Solar lantern 130 Street lights 10 Domestic lights 4 Others 9	All	All non functional	Feb-99 Phase 1	30
5	Electrification of three Villages in Meghalaya	NEC(FIN)/1-33/96-97/03 17/04/1996	Pala, Ringibah & Mawliepoh villages	Solar lantern 334 Solar street light 45 Rice pounding unit 3	Not evaluated	due to logistical constrai	Phase 2	33
6	Electrification of six Villages in Meghalaya	NEC/RRE/282/97-98/57 27 03 1998	Nongrim, Warding, Belahari, Muthlongr, Nongjri, Wahsarang, & Nongpriang villages	Solar lantern 480 Solar street light 17	All	Functional	Jan-01 phase 2	33
7	Installation of 7500 LPD SHWS and 3x2 kW SPV grid hybrid power pack	NEC/ RRE/282/97-98/58 27 03 98	KJP Synod hospital Jowai	SPV power pack 4 Solar water heater 1	All	Functional	Jan-00 phase 2	34 & 44
8	Installation of SPV lanter and streetlights in 15 remotes villages in Jowai	NEC(FIN)/1-33/96-97/16 Dt 05/02/1997	Saiphung area Jaintiya hills district	Solar lantern 537 Solar street light 45	All	201 lanterns functional 15 streetlights functional	May-00 phase 2	35

9 Electrification of Mualsei Village in Jaintia Hills	NEC/FIN/1-33/95-96/263 25/3/96	Mualsei village Jaintiya hills district	Solar lantern 134 Solar street light 24	All	24 lanterns functional 4 streetlights functional	May-00 phase 2	35
10 Electrification of two Villages in Meghalaya	NEC/RRE/282/97-98/59 27/3/98	Khrang, Kongthong East Khasi hills	Solar lantern 158	All	146 lanterns functional	Jan-00 Phase 2	36
11 Installation of 5000 LPD S H W S	NEC(FIN)/1-25/89-90/10 27/10/1989	Orchid Resort Barapani, Ri Bhoi	Solar water heater 1	1	Non functional	Jul-98 Phase 1	47
12 RRE Scheme (I) 8 Cum Biogas Plant (II) Wi Mill (III)2x500LPD,SHWS	NEC(FIN)/1-25/88-89/74 22/08/1989	R K Mission Cherrapunjee	Solar water heater 2 Biogas plant 1 Wind mill 1	All	SWHS non functional Wind mill and biogas plant not commissioned	Aug-98 Phase 1	68 and 47
13 100kw wood Gasifier	NEC(FIN)/1-33/89-90/38 27/03/1990	Darugiri Saw Mill East Garo hills	Gasifier 1	1	Non functional	Aug-98 Phase 1	69
14 Non-Conventional Energ Park at St Anthony's College, Shillong	NEC(FIN) /1-33/92-93 06/11/1992	Shillong	16 systems	All	7 systems functional	Jul-98 Phase 1	79
15 Mobile Exhibition van	NEC(FIN)/1-33/94-95/86 20/03/1995	Shillong	13 systems	All	Functional	Jul-98 Phase 1	81

MIZORAM

S N	Name of the Scheme	Reference sanction No Date	Location	Type and no of systems	No of system evaluated	Status	Phase & year of evaluation	Reference page no
1	Installation of 15 nos street lights at Presbyterian Hospital	NEC/RRE/282/97-98/62 27/3/98	Durtlang, Aizawl	SPV Street lights 15	15	Functional	Jan-01 Phase 2	36
2	10 nos SPV streetlights and 50 nos SPV lanterns at AGAPE Complex	NEC(FIN)/1-33/97-98/20 20/05/97	Aizawl	SPV Street lights 10 Solar lantern 50	All	8 sreetlights functional 48 lantern functional	Dec-98 Phase 1	37
3	Electrification of 20 nos Churches	NEC(FIN)/1-25/96-97/98 26/03/97	10 villages in different districts	Solar lantern 60	27	All nonfunctional	Jan-01 Phase 2	37
4	Electrification of Parva village	NEC(FIN)/1-33/95-96/260 25/03/1996	West Chimtumpui	Solar lantern 160 SPV Street lights 10	ot evaluated		Phase 1	38
5	Electrification of Selam village	NEC(FIN)/1-25/96-97/78 13/03/97	Aizawl East district	Solar lantern 140 SPV Street lights 7	All	30 lanterns functional 2 streetlights functional	Dec-98 Phase 1	38
6	Electrification of Hriangmun Village	NEC(FIN)/1-25/95-96/55 26/02/96	Aizawl East district	Solar lantern 70	ot evaluated		Phase 1	39
7	Electrification of 4 villages in Mizoram	NEC/RRE/282/97-98/61 27/3/98	1 Fungkah Village 2 Rawlbuk Village 3 Vartek Village 4 Vartekkai Tuipui Village	Solar Lantern, 140 SPV Str Light-12	All	Functional	Jan-01 Phase 2	39
8	5000 LPD SHWS at Presbyterian Hospital	NEC(FIN)/1-33/95-96/142 14/12/95	Durtlang, Aizawl	1 no SWHS 5000 LPD capacity	1	Functional	Dec-98 Phase 1	49
9	Solar water heating system at GreenWood Hospital	NEC(FIN)/1-33/96-97/103 30/10/96	Aizawl	1 no SWHS 1000 LPD capacity	1	Functional	Dec-98 Phase 1	49

10 Solar hot water systems at Charity homes	NEC(FIN)/1-25/96-97/79 14/03/97	Aizawl and Kolasib	4 nos SWHS 250 LPD capacity each	4	All functional	Dec-98 Phase 1	50
11 Ramrilui micro hydel Scheme (2x150 kw)	NEC(FIN)/1-33/91-92/310 28/02/1992	Lungrang village Lunglei district	2 x 150 kW, pelton	2	1 turbine functional	Dec-98 Phase 1	
12 Installation of 1x50 kW Vawralui microhydel project	NEC(FIN)/1-33/91-92/353 20/03/1992	Khawlien village Aizawl East district	1x 50 kW, Francis	1	Functional (only in monsoon)	Dec-98 Phase 1	59
13 Leiva Micro Hydel Project (1x50 kw)	NEC(FIN)/1-25/93-94/45 05/01/1994	Kawlbem village Aizawl East district	1 x 50 kW, Francis	1	Yet to be commissioned	Dec-98 Phase 1	60
14 Scheme for establishment of Energy Park in Mizoram	NEC(FIN)/1-25/92-93/45 15/12/1992	Aizawl	Solar systems 5 Biomass systems 3 Wind Mill 2	All	6 systems functional	Dec-98 Phase 1	82

NAGALAND

S N	Name of the Scheme	Reference sanction No and date	Location	Type and number of systems	No of system evaluated	Status	Phase and year of evaluation	Reference page no
1	Duilumroi MHP 2 x 100 kW	NEC(FIN)/1-25/93-94/5 7/2/94	Poilwa & Dzulaki vill Kohima district	2 nos 100 kW each	2 nos	Yet to be commissioned	Jan-99 Phase 1	60

TRIPURA

S N	Name of the Scheme	Reference sanction No and date	Location	Type and number of systems	No of system evaluated	Status	Phase and year of evaluation	Reference page no
1	Employment generation for tribal youths of NER through solar lantern	NEC(FIN)/1-25/91-92/7 23/01/1992	NB Institute of Rural Tech, Agartala	Solar lanterns, tool box & PV module 50 nos	50 nos	Functional 50	Aug-98 Phase1	39
2	Energy Park in Agartala	NEC(FIN)/1-25/93-94/5 1/3/94	Sukanata Academy Agartala	Solar & wind systems 7 Biomass systems 6 Hydro & others 4	17	All functional	Aug-98 Phase1	84
3	Setting up of Renewable Energy Complex at Kalachara	NEC(FIN)/1-33/96-97/2 14/03/1997	Kalachara	Details not avaiable		Functional (as reported by IA	Feb-01 Phase 2	85

ARUNACHAL PRADESH

S N	Name of the Scheme	Reference sanction No Date	Location	Type and no of systems	o of system evaluated	Status	Year of evaluation
1	Installation of 3 kW SPV power plant in Gensi Block	NEC(FIN)/1-33/91-92/372 24/03/1992	Piri village West Siang dist	1 no (3 kW) solar power plant	1	Functional	Dec-98 Phase 1
2	SPV Street lighting system in 8 villages	NEC(FIN)/1-33/91-92/362 21/03/1992	Kameng,Siang Ppare, Dibang	97 nos solar street lights	56	2 functional	Dec-98 Phase 1
3	Installation of solar fencing in five villages in Arunachal Pradesh	APEDA/195/97-98/ 2000-2001	Papumpare district	5 systems (covering 34 kms)	5	Functional	Jan-01 Phase 2
4	Electrification of Korang village in Arunachal Pradesh	NEC/RRE/282/97-98/56	Doimukh block Papumpare district	Solar DLS 25 Solar TV 1 Solar pump 1		Yet to be implemented by APEDA	Jan-01 Phase 2
5	Electrification of Bobia village in Arunachal Pradesh	NEC/RRE/268/97-98/803	Pasighat block East Siang district	Solar DLS 48 SPV streetlights 15 Solar pump/TV 2		Yet to be implemented by APEDA	Jan-01 Phase 2
6	Utilisation of solar energy system in Daporijo	NEC(FIN)/1-33/92-93/191 10/3/92	Daporijo block Upper Subansari	Water purifier 5 Solar lantern 80	85	All non functional	Dec-98 Phase 1
7	Installation of renewable energy System in VKV	NEC(FIN)/1-25/92-93/97 10/3/92	VKV Oyan East Siang district	26 SPV devices & 1 SHWS	27	11 SPV devices functional	Dec-98 Phase 1
8	RRE Scheme-I) setting up Urjagram II) Solar hut at Tawang	NEC(FIN)/1-25/90-91/36 19/07/1990	I)West Siang dist II) Tawang district	One solar hut & one Urjagram	only solar hu evaluated	Solar hut yet to be commissioned	Sep-98 Phase 1
9	Development of 20 nos gharats in Arunachal Pradesh	NEC(FIN)/1-25/94-95/3 23/05/1994	Tawang & Kameng districts	13 water mills	13	Functional 3 Non functional 1 Under construction 9	Dec-98 Phase 1

10 Mini Micro hydel schemes in 10 areas capacity from 10 - 50 kW	NEC(FIN)/1-25/95-96/01 08/05/1995 (REV)	Tawang & Kameng districts	11 micro hydel systems	11	Functional 1 Non functional 4 Under construction 6	Dec-98 Phase 1
11 IREP Program of Kalaktang CD Block	NEC(FIN)/1-33/91-92/340 20/03/1992	West Kameng district	1367 devices	1250	1073 devices functional	Dec-98 Phase 1
12 Mobile Exhibition Van	NEC(FIN)/1-33/95-96/18 05/06/95	Itanagar	11 devices	11	All functional	Sep-98 Phase 1
13 Seting up of RRE equipments in NERIST Campus	NEC(FIN)/1-33/93-94/164 07/02/1994	Nirjuli, Itanagar	28 devices	28	All functional	Dec-98 Phase 1

Status of systems and schemes

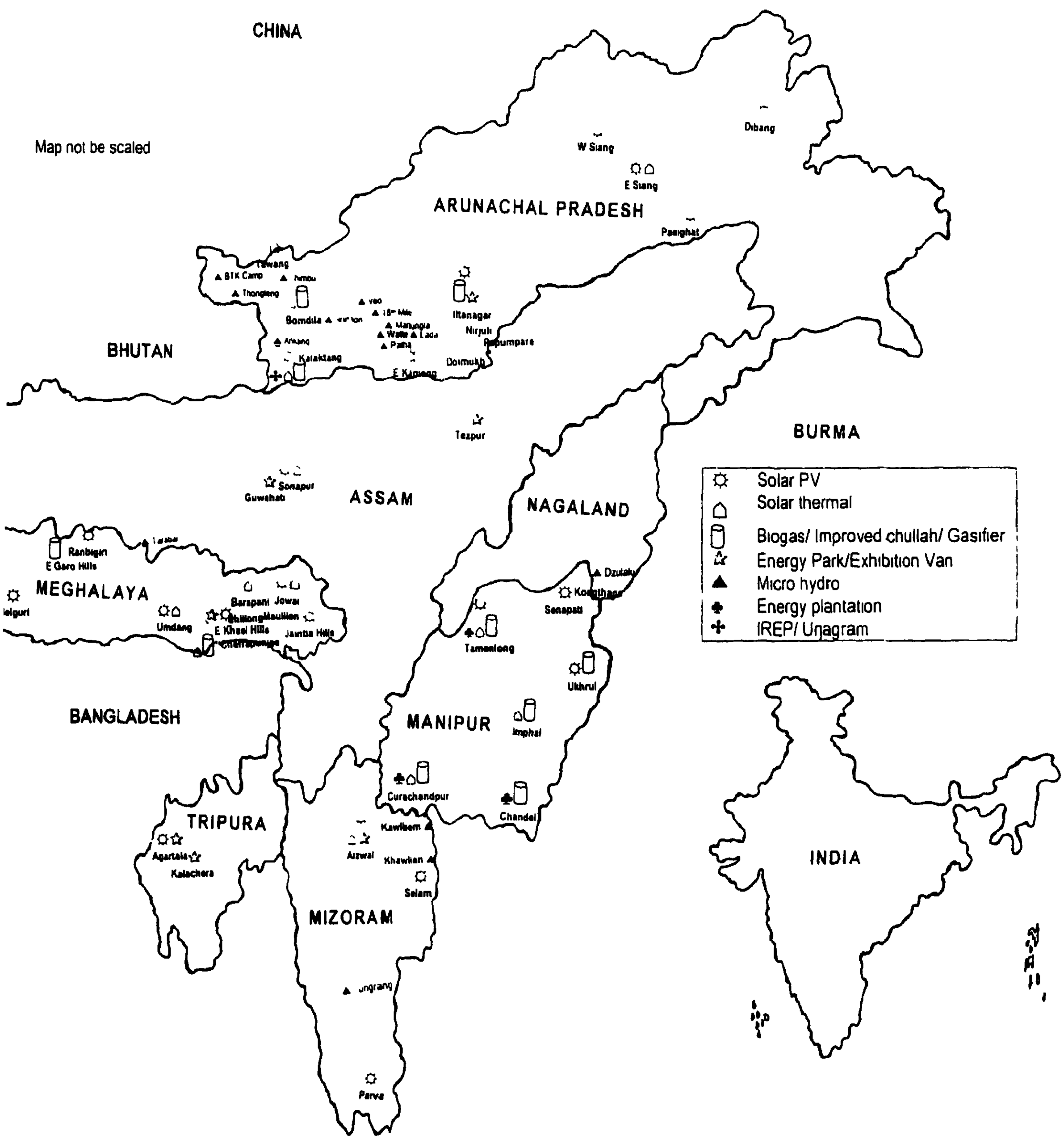
Technology wise status of systems implemented under NEC plan

Technology	No of systems	No of systems evaluated	to be commissioned	non functional	functional	Functionality percentage*
Solar photovoltaic	3779	3083	92	1378	1613	52.32 %
Solar lantern	2774	2177	-	1007	1170	53.74 %
Domestic lights	530	530	73	112	345	65.09 %
Street lights	401	305	15	213	77	25.25 %
Power plants	9	9		2	7	77.78 %
Water pumps	5	5	2	2	1	20.0 %
TV/PAS/CHP	22	22	2	13	7	31.82 %
Water purifier	8	8	-	8	0	0
Fencing/others	30	27	-	21	6	22.22 %
Solar water heaters	26	26	1	16	9	34.62 %
Hydro/water mill	29	29	17	6	6	20.69 %
Wind mill	1	1	1	-	-	-
Biomass gasifier	1	1	-	1	0	0
Improved chulha	867	667		667	0	0
Energy plantation sites	3	2	-	1	1	50.0 %
Biogas plant	2	2	1	1	0	0
IREP scheme systems	1367	1250	-	177	1073	85.84 %
Energy park & exhibition van	10	10	1	1	8	80.0 %

* Functionality percentage is w r t number of systems evaluated

State-wise status of schemes implemented under NEC plan

State	*Scheme sanctioned*	*Scheme evaluated*	*Scheme completed*	*To be commissioned*	*Functional*	*Partly functional*	*Non functional*
Arunachal Pradesh	13	13	11	2	4	5	2
Assam	7	7	4	3	3	-	1
Manipur	7	7	7	-	-	1	6
Meghalaya	15	14	15	-	4	4	6
Mizoram	14	12	13	1	6	4	1
Nagaland	1	1	-	1	-	-	-
Tripura	3	3	3	-	3	-	-
Total	**60**	**57**	**53**	**7**	**20**	**14**	**16**



Sketch map showing the location of RRE scheme funded by NEC in Northeastern Region

1 Introduction

The renewable energy programme in the Northeastern region was initiated in the early eighties, with initial emphasis on biogas technology. Subsequently, over the years various technologies ranging from improved cookstoves and biogas plants to wind energy generators and micro-hydel were disseminated under this initiative However, till date such technologies have had limited impact in the region and also the effective functioning of the installed systems has been suffering from problems related to operation and maintenance.

Solar photovoltaic (SPV) systems have been installed in remote areas where extending the grid is difficult Besides these, solar lanterns have also been widely distributed in rural areas Biogas plants and improved *chulhas* are being disseminated in areas where the climatic conditions are conducive for their implementation Wind mapping stations have been set up in different parts of the region, and wind pumps and wind aerogenerators have also been installed Though biomass gasifiers were installed mainly in saw mills and plywood factories, these have not been successful largely due to operational difficulties Accessibility to many areas in the region remains a constraint which has been the main reason for the poor performance of renewable energy technologies (RETs) systems, as proper maintenance of the systems cannot be undertaken

In all the Northeastern states, the renewable energy activities are undertaken under the State Plan with support from Ministry of Non-conventional Energy Sources In addition, a large number of schemes are implemented under the North Eastern Council (NEC) regional plan In all the states, nodal agencies comprising state government departments and/ state renewable energy development agencies are responsible for implementation More recently, non-governmental agencies and academic institutions have also been entrusted with implementation of RETs in respective states

NEC's Renewable Resources of Energy schemes

The North Eastern Council (NEC) was set up in 1972, as an advisory body to plan and implement Central government aided developmental projects in the region, in addition to the respective state plans The Council has a separate Renewable

Resources of Energy (RRE) division, to look after the planning, implementation and monitoring of renewable energy systems in the region.

The RRE schemes were initiated in the early eighties and since then over a hundred schemes have been sanctioned But till the mid nineties, NEC did not have detailed information regarding the status of these schemes namely, the number of systems functional, the problems encountered, and impact on the beneficiaries, etc., which would help it to improve its strategy for more effective implementation of these schemes. In 1995, NEC commissioned TERI as an independent agency to assess the status of the schemes sanctioned so far.

The evaluation study made by TERI presented detailed information on the status of the renewable energy technologies disseminated under the NEC plan. In most of the schemes, the issues highlighted were lack of training and awareness among the beneficiaries and the absence of a formal monitoring and evaluation system. However, most of the problems related to the performance of the systems, are institutional in nature These were concerns such as delays in project sanctioning and in implementation of the schemes, lack of feasibility reports supporting the project proposal and non-existence of an evaluation and monitoring mechanism. The main recommendation of the study was that NEC should commission independent evaluation of the schemes sanctioned regularly on a yearly basis. More emphasis should be on the functionality of the systems rather than the completion of the schemes

Study objectives

Given this background of the status of renewable energy technologies in the Northeastern region implemented under the NEC plan, TERI conduct a concurrent evaluation study for the period of two years (1998-2000) Under the present study, the project would focus on assessing and streamlining the evaluation mechanism, by periodically surveying the schemes sanctioned This will be carried out in two phases· Phase I will include schemes sanctioned between 1993-95 and during 1995-96, and Phase II will cover those sanctioned during 1996-1998

The present study is an attempt to consolidate the information regarding the various renewable energy schemes implemented under the NEC's RRE programme in all the states of the region A technical performance evaluation of RETs disseminated was carried out in all the seven northeastern states, where these schemes have been implemented The present study is a consolidated report for Phase I and Phase II schemes evaluated The objectives of the study are as follows

1. to examine the process of implementation of specific systems (planning, system configuration, installation, and monitoring)
2. to evaluate the technical and operational performance of various renewable energy systems installed and suggest rectification measures for non-functional systems
3. to study the factors responsible for the success and failure of the schemes, based on the evaluation of the existing systems, suggestions to strengthen the programme implementation in future

Methodology

To achieve the aforementioned objectives, the methodology adopted is as follows

Secondary data collection

Secondary information regarding the location of the systems, implementing agencies and type of systems was collected from NEC, as well as from respective state renewable energy development agencies and other non-governmental implementing agencies In addition, discussions regarding the procedure for implementation and operation and maintenance of systems were also held with the implementing agencies in the respective states

Evaluation

The systems installed under the NEC plan in all the seven states were evaluated. Efforts were made to survey all (100%) the RET schemes sanctioned by NEC However owing to logistics constraints, about 6% schemes could not be surveyed. Under the schemes evaluated, 100% of the installed micro hydro schemes, biogas plants, solar thermal systems, SPV power plants, aerogenerators, energy parks and mobile exhibition vans were surveyed For SPV lanterns, SPV domestic lighting systems, and improved *chulhas,* a sample survey (up to 70% of the installations) was conducted subject to accessibility to the project sites

For field surveys, local NGOs, academic institutes, and government organisations were also involved The evaluation procedure consisted of (i) technical evaluation, (ii) evaluation of maintenance and management system, and (iii) identification of reasons for success/failure of the RETs. Checklists and interview guides were used to assess the technical performance of these systems and impact on the beneficiaries

Scope of the study

The objective of this study was to evaluate all RET systems installed under NEC scheme in the seven states of the region, but because of uncertain law and order conditions prevailing in part of the region and also due to logistical constraints, some of the locations could not be surveyed. However, information regarding such installations has been collected from the respective implementing agencies. In Mizoram, Meghalaya, and Manipur, information about some schemes was collected from the implementing agencies, as visits to the sites were not possible. Efforts were made to involve NGOs in the study and the response was good, both in terms of interest and co-operation

Study area

Northeastern region

The north-eastern India comprises the seven states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, covering a total geographical area of 2 55 lakh km^2 with a population of 3 15 crores (1991 Census) Of this population, only 49 19 per cent is employed About 75 per cent of this work force is engaged in the agriculture sector The bulk of the population here is rural in character with the proportion of rural population ranging from 53 9 per cent in Mizoram to 89 per cent in Assam

The Northeastern region is located in the geographical periphery of India, with distinct geographical and cultural identity of its own The region can broadly be divided into two physiographic divisions plains and hills About 70 per cent of the land is hilly Most of Assam (except Karbi-Anglong and North Cachar hills), parts of Tripura and Manipur are in the plains The prevalent agricultural practices differ across the regions, the most striking being the *jhum* (shifting cultivation) practised in the hills In the plains, settled agriculture is prevalent, generally with irrigation, which is not very prominent in the hills Given the cultural diversity in the society, consisting mainly of indigenous communities, the lifestyles, cooking practices and many other socio-economic activities vary across the region, and even within the same state

Arunachal Pradesh

Arunachal Pradesh is located between 26 6 and 29 45 °N latitudes and between 91 6 and 97 35 °E longitudes Surrounded by Bhutan on the west, China on the North, Myanmar on the east, and Assam on the south, the state sprawls over an

area of 83 743 sq. km Evergreen and semi-evergreen forests cover more than 60% of Arunachal Pradesh, with numerous turbulent streams, roaring rivers, deep gorges, lofty mountains, snow-clad peaks, and an enormous diversity of flora and fauna With humid climate in the low altitudes, the valleys of Arunachal Pradesh are covered by swampy dense forests, particularly in the eastern region However, it becomes exceedingly cold in the higher regions. The rainfall here is among the heaviest in the country, with an annual average of more than 300 cm

Arunachal Pradesh has a population of 864558 (1991 census) spread thinly over hilly tracts, in 3294 villages and 10 towns, divided in 14 districts. More than 80% of its population lives in villages, a number of these located in the remote areas with no access to grid connected electricity. The activities under the renewable energy sector in Arunachal Pradesh were initiated as early as in the late fifties, when a biogas plant of 1 m^3 capacity was installed in Pasighat, East Siang district After a lull, renewable energy programme gained a momentum in the early eighties under the renewable energy programme of Rural Works Department (RWD) The Arunachal Pradesh government has provided a blanket subsidy of 90% on renewable and non-conventional energy systems for the rural masses of the state. In addition to the central government sponsored schemes such as NPBD, NPIC, IREP, and NRSE, several state sponsored schemes have also been initiated. The North Eastern Council has also funded projects under its RRE schemes.

The Arunachal Pradesh Renewable Energy Development Agency (APEDA) has been identified as the nodal agency for the implementation of most of the renewable energy technologies including mini/micro hydro power systems Department of Power is the other nodal agency for the implementation of mini-micro hydel projects Apart from these departments, non-governmental agencies such as Social Work Research Centre, and institutions such as Vivekananda Kendra Vidyalayas and Ramakrishna Mission are actively involved in dissemination of RETs with funding from NEC and other sources.

Assam

Assam popularly known as the *land of blue hills and red rivers,* is located between 25.5 °N to 28 °N latitude and 90 °E to 96 °E longitude. It shares its boundaries with Arunachal Pradesh in the north and north-east, Nagaland in the east, Mizoram and Manipur in the south-east, Tripura in the south-west, West Bengal in the west and shares international boundary with Bhutan on the north and Bangladesh on the south and south-west. The total area of the state is 78

348 sq. km spread over 23 districts, two of which are hilly The total population of the state is 22 294 562.

The climate of Assam is that of a typical sub-tropical region, with mild winters and warm and humid summers. The South-west monsoon inundates the area with heavy rainfall during the period from May to September and ensures an average humidity in excess of 85% during these months. The principal language of the state is Assamese and is also the connecting language for all the northeastern states.

Assam is rich in fossil fuels like oil and gas. The state also has substantial renewable energy sources like solar, hydel and biomass Even then the per capita consumption of energy in the state is among the lowest in the country, which indicates low level of economic development Almost all domestic energy needs in the rural areas are met from biomass sources such as fuelwood and agricultural residues

The Assam Science, Technology and Environment Council (ASTEC) which is the state s nodal agency is responsible for implementation of RETs schemes. In addition, state government departments such as Rural Development Department (RDD), Khadi Village and Industries Board (KVIB), Khadi Village and Industries Commission (KVIC), District Rural Development Authority (DRDA), and Department of Science Technology and Environment (DSTE) and Assam State Electricity Board (ASEB) are also involved in the implementation.

Manipur

Manipur is located between 90 03°E and 93.20°E longitudes and between 23 83°N and 25.65°N latitudes. It is bounded on the east by Myanmar, on north by Nagaland, and on the west by Assam, and on south-western side by Mizoram It has a population of 1 826 714 spread over an area of 22 327 sq km The bulk of the state's population lives in 2035 villages spread over eight districts Manipur, Naga and Kuki communities constitute the population of the state The principal language is Meithei (Manipuri) though, 12 other dialects are spoken in the state The hill districts of the state comprising Nagas and Kukis suffer from the ethnic clashes related to militancy

The renewable energy programme in the state started in early eighties The state nodal agencies responsible for implementing renewable energy technologies in Manipur are the Power Department, Animal Husbandry & Veterinary Department, etc The Department of Science, Technology and Environment (DSTE) was set up in 1985 to act as the nodal agency for the state for planning, coordinating and promoting science and technology for application

in various developmental programmes, including renewable energy activities In 1999 a separate renewable energy agency was created to undertake RRE activities In addition, the Department of Power implements micro-hydel schemes in the state Under the renewable energy programme, a wide range of systems - from biogas plants to micro-hydel have been installed.

Meghalaya

The hilly state of Meghalaya is placed between 25 15°N and 26 2°N latitudes and between 89 45°E and 92 47°E longitudes It is located in the north-eastern corner of India and bounded on the south and west by Bangladesh, on the north by Assam Comprising Khasi, Jaintia and Garo hills, Meghalaya is spread over an area of 22 429 sq km It has a population of 1 774 778 persons living in 5 492 villages and 13 towns in 7 districts. More than 80 percent of the population lives in villages and 63 35 percent of these villages have a population of 200 or less Fuelwood constitutes the primary energy source in the rural areas with a low penetration of commercial fuels. Despite being the only power surplus state in the region, many villages in Meghalaya still remain unelectrified owing to their remote locations

Meghalaya Non-conventional and Rural Energy Development Agency (MNREDA) is the designated nodal agency, which was formed with the objective of formulation and implementation of demonstration, and extension projects related to non-conventional and renewable energy sources Apart from MNREDA, there are other agencies such as the Agriculture department, the Planning department and Meghalaya State Electricity Board, which are also involved in the dissemination process.

Mizoram

Mizoram is a predominantly hilly state located between 92.15° E and 93.29°E longitudes and 21.58°N and 24. 35°N latitudes It is bounded on east by Myanmar, on the northeast by Manipur, the north by Assam, on the west by Tripura and on the south-west by Bangladesh It has a total population of 689 757 spread over 21 081 sq. km With a rural population of 54%, the state boasts of the highest literacy rate among all the seven northeastern states. Mizoram is one of the most peaceful states of the region.

The New and Renewable Sources of Energy (NRSE) programme in the state has been under implementation since the beginning of the VI five-year Plan. Since then, numerous programmes related to renewable energy have been carried out. The state has separate nodal agencies for different renewable energy

programmes. The NPBD programmes are executed by Animal Husbandry and Veterinary department, and NPIC programme by Department of Rural Development. All other renewable energy technologies such as SPV, solar thermal, and wind are now being disseminated by the recently formed Zoram Energy Development Agency. The state Power and Electricity Department implement mini-micro hydel schemes.

Nagaland

Nagaland is located between 25.6°N and 27.4°N latitudes and 93.20°E and 95.15°E longitudes. It is bounded on the east by Myanmar, Assam in north and west, by Arunachal Pradesh in the northeast, and by Manipur in south. It has a population of 1 215 573 spread over an area of 16 579 sq. km. The state's 83% the population lives in rural areas, dominated by tribal communities The state is in center of ethnic clashes among Naga communities and growing militancy, hampering the developmental progress.

Renewable energy programme in the state started in mid eighties, with main thrust on popularisation of biogas and improved cookstoves. The state has separate nodal agencies for different renewable energy programmes. The centrally sponsored biogas and improved cookstoves programmes in the state are implemented by State Rural Development Agency and Rural Development Blocks. Development Commissioner, Government of Nagaland looks after the wind energy systems. Department of Power, was the nodal agency for implementation of rest of the renewable technologies till 1991-92, after which a separate body called Department of Science, Technology and Environment (DSTE) has been created which has been recognised as the nodal agency for the promotion of renewable energy technology technologies in the state More recently, the newly formed Nagaland Renewable Energy Development Agency has been entrusted with the execution of RETs activities in the state

Tripura

Tripura is located between 23°N and 24 4°N latitudes and 91.2°E and 92.3°E longitudes. It is bounded on the east by Mizoram, on northeast by Assam and on north, west, south and southeast by Bangladesh. It has a population of 2 744 827 spread over an area of 10 491 sq km There are 4 727 villages in the state supporting 85% of the total population Majority of the population comprises tribal communities and migrants from Bangladesh One of the major problems faced by the state is its inaccessibility (it is accessible by road only from Assam) leading to increase in cost of goods The state faces the problem of illegal

immigrants from Bangladesh and internal conflicts within different communities, leading to slow growth of development

The renewable energy programme in Tripura gained importance in early eighties The topography and climate of the state is such that a number of renewable energy technologies can be implemented The climate of the state is well suited for biomass technologies, solar thermal and photovoltaic systems. Wind energy systems and small hydro have also been implemented and are functional at specific locations.

The Department of Power was designated as the implementing agency for dissemination of RETs in the state in 1982-83 Subsequently, the programme was executed by the Department of Science, Technology & Environment (DSTE) At present, a separate agency called Tripura Renewable Energy Development Agency is the designated state nodal agency for implementation of renewable and non-conventional sources of energy

2 Solar photovoltaic schemes

Solar photovoltaic (SPV) systems/devices are amongst the most widely accepted renewable energy (RE) technologies in the north-eastern states Further, there is enormous potential for dissemination of this technology as a substantial number of villages in the region are remote and extending of grid electricity to such areas is difficult In such cases, SPV provides a viable option in providing electricity for domestic as well as commercial uses Solar PV systems convert sunlight directly into useful electricity. This process is called the photovoltaic (PV) effect. The energy generator in a PV system are the solar cells, which are essentially thin wafers of silicon The electricity thus generated can be used either directly or stored in batteries or directly fed into the grid.

The devices that are popularly in use are solar lantern, solar domestic lighting systems, street lighting system, power plant, and solar water pumping systems The PV systems are modular in nature and can be installed as per the requirement of the users. A solar lantern consists of a SPV panel (10 Wp), a battery of 6/12 V of 12/6.5 Ah, a lamp (luminaire) of 5 W or 7 W with 2/4 pin arrangement and electronic components, all placed in a casing made of metal, plastic, or fibreglass This device can be used for 3-4 hours daily provided the battery of the system is fully charged Because of its portable nature it has gained popularity among villagers for indoor as well as outdoor applications for their day to day activities.

Solar streetlight is a stand-alone system with one or two panels, a lead-acid battery, and a luminaire with a CFL (compact fluorescent lamp) or FL (fluorescent lamp) These are available in two models depending upon the operating hours In one model, a battery of shallow capacity is provided to operate the system for 4-6 hours daily whereas in the other model a battery of bigger capacity is used to operate system for nearly 12 hours. These systems are used for outdoor lighting at night wherein solar panels are placed in shadow free area for battery charging during the daytime

Solar domestic lighting systems are designed to meet the lighting requirements of households or community. The systems approved under the MNES (Ministry of Non Conventional Energy Sources) programme have

provision for either two light points (i.e., two CFL) or two light points with one extra point for running a television/fan.

The solar photovoltaic system, because of its modular nature, can be custom designed for capacities ranging from a few watts to kilowatts. And a solar power plant exemplifies this flexibility, as it comprises a series and parallel combination of solar modules, which can be designed for required capacity. An SPV power plant consists of a combination of solar module, a battery bank, and the inverter (to convert DC into AC electricity). Electricity generated from the power plant is supplied to the users/households connected to the power plant. Normally the luminaire provided is a CFL of 9/11 W. A solar water pumping systems consist of a combination of solar module, AC/DC pump, and a storage tank as a back-up to provide water during non-sunshine hours. An inverter is also required if the pump functions on AC electricity.

Implementation of SPV schemes

Under the North Eastern Council's (NEC) RRE (Rural and Renewable Energy) programme, SPV schemes account for the largest share of the total schemes sanctioned to the respective states during the last decade. Under this programme, nearly all types of SPV systems/devices were disseminated in the region. In light of the prevalent difficult terrain, scattered pattern of settlement and low level of development, expansion of centralised grid power supply is a difficult proposition in some of the areas of the region. In such conditions, SPV technology provides a viable alternative for rural electrification and other uses. Further, the biggest advantage of the SPV systems is that these are modular in nature and can be designed as decentralised power units for local needs.

The implementation of SPV schemes is undertaken largely by state renewable energy development agencies, and reputed NGOs (Non Governmental Organisations) The state renewable energy development agencies also involve the NGOs in implementing the RRE programmes.

The implementing agencies are also responsible for the maintenance of the systems covered under the RRE schemes. For schemes implemented by NGOs, maintenance as well as training of locals for the respective areas and rectification of minor defects is the responsibility of the NGO. It was observed that maintenance was effectively done at the initial stage i.e. few months after the implementation of the scheme, and subsequently no maintenance was carried out The lack of maintenance is mainly due to the remoteness of the project site, lack of availability of the spare parts and frequently occurring operational problems of the systems. Although the problems encountered have

been minor, and were easily repairable, but because of ignorance of any kind of maintenance guidelines for the users, the rectification was neglected by the users as well as the implementing agency Thus, systems were damaged owing to long periods of non-functioning

Functional status of SPV schemes

Amongst all schemes under study, lack of availability of maintenance facilities was found to be the main reason for non-functional status of the devices. Most solar lanterns were found be non-functional owing to the problems in battery, luminaries and electronics. Those in functional state are few because of personal care and maintenance In case of battery damage, the continuous non-operation of the system resulted in problems in the battery which users found difficult to rectify Street lighting systems suffered most because of non-availability of trained persons for maintenance Being public property, when problems were encountered, the onus of repairing these was on the state nodal agency The major defects were found with the batteries and the electronics However, solar modules of these systems are in working condition and can be reused In some of the street lighting schemes, it was found that the modules were kept at a centralized site from where connections were given to the individual luminaries The major drawback of this arrangement is that in case of the minor faults, the entire system becomes non-functional

Most of the solar domestic lighting systems were installed in Assam by ASTEC and majority of them is found to be functional. The power plants installed in Meghalaya by MNREDA are also found to be functional. Solar water purifiers suffered from non-functioning of the UV lamp and the battery In addition no expertise was available for maintenance of the systems on site Solar water pumping systems were also installed but only one was found functional In most of the systems, solar modules are available at the site but have been disconnected. The functional status of SPV schemes (Table 2.1) and scheme details in respective states are as follows

Table 2.1 Functional status of SPV systems under NEC plan (state-wise)

SPV System	Number of systems	Number of system evaluated	To be commissioned	Non functional	Functional
Solar lantern					
Arunachal	85	85	-	85	0
Assam	178	178	-	177	1
Meghalaya	1791	1457	-	606	851
Mizoram	620	357	-	139	218
Tripura	100	100	-	0	100
Total	2774	2177	-	1007	1170
Domestic lights					
Arunachal	84	84	73	5	6
Assam	382	382	-	43	339
Manipur	60	60	-	60	0
Meghalaya	4	4	-	4	0
Total	530	530	73	112	345
Street lights					
Arunachal	117	76	15	57	4
Assam	8	8	-	8	0
Manipur	76	76	-	76	0
Meghalaya	146	101	-	65	36
Mizoram	54	44	-	7	37
Total	401	305	15	213	77
Solar water purifier					
Arunachal	6	6	-	6	0
Assam	1	1	-	1	0
Meghalaya	1	1	-	1	0
Total	8	8	-	8	0
Solar pump					
Arunachal	3	3	2	1	0
Assam	2	2	-	1	1
Total	5	5	2	2	1
Solar power plant					
Arunachal Pradesh	1	1	-	0	1
Manipur	1	1	-	1	0
Meghalaya	7	7	-	1	6
Total	9	9	-	2	7
Solar TV/PAS/OHP					
Arunachal Pradesh	5	5	2	0	3
Assam	13	13	-	9	4
Meghalaya	4	4	-	4	0
Total	22	22	2	13	7
Rice pounding unit/ fencing /others					
Arunachal Pradesh	5	5	-	0	5
Assam	18	18	-	17	1
Meghalaya	7	4	-	4	C
Total	30	27	-	21	6
Grand total	3779	3083	92	1378	1613

Arunachal Pradesh

Table 2.2 3kW SPV power plant in Gensi Block [NEC (FIN)/1-33/91-92/372, 24.03.1992]
Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
3 kW solar power plant Piri village, Gensi block, West Siang district 1994	1 Luminaire 2 nos, 9 W CFL per household Streetlight connection 11 lights, 11W CFL Functional	Technical specifications Modules 96 nos, 36 Wp Batteries 48 nos tubular lead acid, 2 V Charge controller 48V/3kW Electricity supply DC supply Benefits/problems ▪ Supply of electricity to 35 households and for street lighting for 4 hr daily (16.20-20 30 hr) ▪ Between August and November 1998, plant operation was suspended due to problems in batteries This was rectified in December 1998 ▪ A timer has been fixed to the plant for automatic switch-off after a set time

Table 2.3 SPV street lighting system in 8 villages
[NEC (FIN)/1-33/91-92/362, 21.03.1992]
Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Street lights Village Jote Chedda Block Seppa District East Kameng 1993	11 7 Non-functional 2 Functional 2 systems not found at site	Technical specification Module 1 no , 36 Wp per system Battery 12 V, 75 Ah Benefits/problems ▪ To provide public lighting in the village ▪ Damaged batteries, wires and luminaire ▪ Modules in working condition Rectification ▪ New batteries and luminaire required

Device/system Location Year of installation/commissioning	Number. of devices Present functional status	Technical specifications, benefits/problems, rectification
Street lights Village. Boro Rakshap, Along District. West Siang. 1993	15 Non-functional	Technical specifications Module. 1 no , 36 Wp per system Battery 6V, 100 Ah Luminaire 1 no., 11W CFL per system Benefits/problems ▪ To provide public lighting in the village ▪ Modules are in working condition ▪ Battery, wiring, and luminaire completely damaged Rectification ▪ Replacement by new batteries, luminaries ar wires
Street lights Village Dage Pottom, Along District West Siang 1993	15 Non functional	Technical specifications Module 1 no , 36 Wp per system Battery 6V, 100 Ah Luminaire 1 no . 11W CFL per system Benefits/problems ▪ To provide public lighting in the village ▪ Modules are in working condition ▪ Battery and luminaire completely damaged Rectification ▪ Revival with replacement of batteries and luminaire
Street lights Village Dube Karbak, Along District West Siang 1993	15 Non-functional	Technical specifications Module 1 no . 36 Wp per system Battery 6V, 100 Ah Luminaire 1 no . 11W CFL per system Benefits/problems ▪ To provide public lighting in the village ▪ Modules are in working condition ▪ Battery discharged and luminaire damaged Rectification ▪ Revival with replacement of batteries and luminaire
Street lights Village Supring (Yinkiong) District Upper Siang 1993	30 Status not known, as the site could not be visited owing to logistical constraints	Technical specifications Module 1 no . 36 Wp per system Battery 6V, 100 Ah Luminaire 1 no . 11W CFL per system Benefits/problems ▪ To provide public lighting in the village

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Street lights Village Apanali District Dibang Valley 1993	11 Status not known, as the site could not be visited owing to logistical constraints	Technical specifications Module 1 no , 36 Wp per system Battery 6V, 100 Ah Luminaire 1 no , 11W CFL per system Benefits/problems • To provide public lighting in the village
Street lights Village Doimukh District Papum Pare 1993	Status not known as the distinction between streetlights installed under NEC plan and other schemes could not be made	Technical specifications Module 1 no , 36 Wp per system Battery 6V, 1000 Ah Luminaire 1 no , 11W CFL per system Benefits/problems • To provide public lighting in the village

Table 2.4 Installation of solar fencing in five villages in Arunachal Pradesh (APEDA/195/97-98/2000-2001)

Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar fencing Village Rose, Sopo, Lower Tubung, Upper Tubung, Hostalum. Block Doimukh District Papum Pare 2000	5 systems (covering a total distance of 34 km) Rose 9 3 km, Sopo 6 7 km Lower Tubung 6 5 km, Upper Tubung 7 km Hostalum 4 5 km Functional	Technical specification of each system Module 2 no, 35 Wp per module Battery 12 V, Automobile battery Wire Voltage 7000-9000 V Wire current 40-60 pulse/minute Benefits/problems • To protect the villages and agricultural fields from elephant attack

Table 2.5 Electrification of Korang village in Arunachal Pradesh(NEC/RRE/282/97-98/56)

Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status*	Technical specifications, benefits/problems, Rectification
SPV home lighting systems Village Korang Block Pasighat District East Siang	25 Yet to be implemented	Technical specification Module 1 no, 35 Wp Battery 12 V
Solar Television Village Korang Block Pasighat District East Siang	1 Yet to be implemented	Technical specifications Not available

Device/system Location Year of installation/commissioning	Number. of devices Present functional status*	Technical specifications, benefits/problems, Rectification
Solar pump Village: Korang. Block: Pasighat District East Siang	1 Yet to be implemented	Technical specifications • Capacity: 900 W

* As reported by APEDA, materials have been procured and transported to the project site for installation.

Table 2.6 Electrification of Bobia village in Arunachal Pradesh (NEC/RRE/268/97-98/803) Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
SPV home lighting systems Village Bobla Block Doimukh District Papumpare	48 Yet to be implemented	Technical specification Module 1 no, 35 Wp Battery 12 V
SPV street lights Village Bobia Block Doimukh District Papumpare	15 Yet to be implemented	Technical specifications Module , 2 nos , 35 Wp per system Battery 12 V, 75 Ah
Solar Television Village Bobia Block Doimukh District Papumpare	1 Yet to be implemented	Technical specifications Not available
Solar pump Village Bobia Block Doimukh District Papumpare	1 Yet to be implemented	Technical specifications • Capacity 900 W

* As reported by APEDA, materials have been procured and transported to the project site for installation

Table 2.7 Utilisation of solar energy in Daporijo [NEC (FIN)/1-33/92-93/19, 10.03.1992]
Implementing agency SWRC (Social Work Research Centre), Daporijo

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar water purifier VK Vidyalaya, Koporijo, Government hospital, Daporijo, SWRC campus Daporijo, Taliha village, Kodac village(all located in Upper Subansiri district) 1993	5 Non-functional	Technical specifications Module 2 nos, 35 Wp per system Batteries 2 nos, 12V, 75 Ah per system Benefits/problems ▪ To supply potable water to the hospital and school ▪ All the systems suffered from damaged UV lamps, and faults in battery and circuit Rectification ▪ New battery and UV lamp required
Solar lantern Daporijo, Dumporijo, Taliha and Nacho-Siyum, blocks, Upper Subansiri district 1993	80 (During distribution 40 lanterns were found defective and returned back to SWRC) 40 non functional	Technical specifications Charger (for one set of 4 lanterns) 10 nos, each comprising 2 modules of 35 Wp Luminaire 1 no 7 W CFL per lantern Benefits/problems ▪ Ten sets of four lanterns each were distributed among the 18 groups of women involved in weaving and tailoring activities ▪ All lanterns suffer from problems in the electronic circuit, battery and luminaire(fused/blackening) ▪ Lanterns operate below their optimum level ▪ Modules in working condition Rectification ▪ Replacement with new battery and luminaire, and repairs in the circuit

Table 2.8 Installation of renewable energy system in VKV Oyan [NEC (FIN) 1-25/92-93/97,10.03.92]
Implementing agency: Vivekananda Kendra Shiksha Prasar Vibhag, Dibrugarh

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Domestic lighting system VKV campus, Oyan, East Siang. 1993	11 6 functional	Technical specifications Module· 1 no., 35 Wp per system Luminaire· 1 no., 9 W CFL Battery 12 V 75 Ah Benefits/problems ▪ DLS were installed in hostel building accommodating 115 students and office premises ▪ Problems in luminaire and circuit Rectification ▪ Replacement of parts in the circuit, and new luminaire required
Solar streetlight VKV campus 1993	5 2 functional	Technical specifications Module. 1 no , 35 Wp per system Luminaire 1 no , 11 W CFL Benefits/problems ▪ Lighting for pathways within school campus ▪ Problems in electronic circuit and luminaries Rectification ▪ New battery and luminaire required
SPV pump VKV campus 1993	1 Non functional	Technical specifications Capacity 350 W Benefits/problems ▪ Water supply for students and school staff ▪ System has been dismantled and modules shifted over the roof of hostel building ▪ Problems identified are with the pump and inverter Rectification ▪ Modules are functional Repairs in pump and inverter

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern VKV campus 1993	5 Non-functional	*Technical specifications* Module 1 no, 18 Wp per system Battery 12 V, 6.5 Ah Luminaire 1 no, 9W CFL *Benefits/problems* ▪ Lanterns were provided to school staff within campus ▪ Problems in circuit and luminaire *Rectification* ▪ Modules in working condition but complete replacement of luminaire and repairs in circuit required
Solar powered television VKV campus 1993	1 Functional	*Technical specifications* Module 2 nos, 35 Wp Battery 2 nos, 12 V, 75 Ah *Benefits/problems* ▪ To provide entertainment for students in evening hours
Solar public address system VKV campus 1993	1 Functional	*Technical specifications* Battery 2 nos, 12 V 75 Ah *Benefits/problems* ▪ PA system is used for school functions
Solar slide projector VKV campus 1993	1 Functional	*Technical specifications* Battery 2 nos, 12 V, 75 Ah *Benefits/problems* ▪ Slide projector is used for making audio-visual presentations
Solar water purifier VKV campus 1993	1 Non functional	*Technical specifications* Battery 12 V, 75 Ah UV lamp *Benefits/problems* ▪ To provide potable water to the students and staff ▪ Functional for two years after installation ▪ Fault in UV lamp and battery ▪ Battery has been shifted to the school building *Rectification* ▪ Battery can be repaired, and with a new UV lamp, the system can be made operational

Note A SHWS is also installed at VKV, under this scheme For details of the system refer Arunachal section, chapter 3

Assam

Table 2.9 Electrification of 9 villages in Kamrup district
[NEC (FIN)/1-33/93-94/261, 31.03.1994]
Implementing agency: Energy Division, ASTEC (Assam Science, Technology and Environment Council), Guwahati

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Domestic light systems 9 villages in Sonapur Circle, Kamrup district Bandergog (57) Pithagog (14) Pessamsaru (19) Markang (46) Barkasarang (57) Marlap (20) Dondorai (30) Magurchilla (68) Kolongpar (57) 1994-96	368 (For breakdown, see the first column) 312 functional 30 Non-functional 26 Partly functional	Technical specification Module 1 no, 15 Wp per system Luminaire 2 per system (7W and 5W CFL) Battery 12 V, 40 Ah Benefits/problems ▪ To electrify individual households. ▪ Society called, Sonapur Hillside Rural Energy Development Society (SHREDS), comprising beneficiaries was formed to maintain the devices ▪ Non-functional systems suffer from problems in luminaire, battery and printed circuit boards ▪ Partly functional systems suffer from uncharged battery and improper positioning of the modules leading to inadequate charging of the battery ▪ Users are satisfied with the performance of the systems and there is a demand for more systems ▪ Beneficiaries pay Rs 10/- per month for maintenance of the system Rectification ▪ Replacement of luminaire is needed ▪ Proper charging of the battery ▪ Luminaries and PCB needs rectification

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems rectification
Solar lanterns SHREDS office Pessamsaru village, Sonapur Circle, Kamrup district 1996	18 1 functional 17 Non-functional	Technical specifications Module 1no , 10 Wp per system Luminaire 7W CFL per system Benefits/problems ▪ SHREDS rents out lanterns to the villagers during festival season ▪ Non functional systems suffer from battery and electronic circuit damage ▪ Some components of electronic circuits of the non-functional systems have been removed for replacement of the defective spares in the DLS Rectification ▪ Modules in working condition, batteries and circuits require complete replacement
SPV pump SHREDS office premises Pessamsaru village, Sonapur Circle Kamrup district 1998	1 Functional	Technical specifications Capacity 228 W Submersible pump Water delivery 7000 LPD storage tank 500 litres Benefits/problems ▪ To provide drinking water to the village ▪ Low water discharge Rectification ▪ Change in tilt and direction of the module recommended ▪ Regular cleaning of module surface required
Solar still SHREDS office premises, Pessamsaru village, Sonapur Circle, Kamrup district 1996	4 1 functional 3 Non functional	Technical specifications Capacity 2 LPD per system Benefits/problems ▪ To supply distilled water for batteries ▪ Stills non-functional because of breakage of glass covers Rectification ▪ New glass covers required

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Domestic lighting system, colour television and Video Cassette Player SHREDS office premises, Pessamsaru village, Sonapur Circle, Kamrup district 1996	1 colour television Functional 1 video cassette player Functional 1 lighting system Non-functional 4 battery 3 functional	Technical specifications Module 6 nos, 35 Wp Luminaire 4 nos, 7W CFL Battery bank 24 V, 160 Ah with inverter Benefits/problems ▪ Television and VCP provide entertainment for the villagers ▪ Luminaries have been removed to replace defective ones in individual homes Rectification ▪ Modules and battery in working condition, only new luminaries required
Community lighting system and powering of portable B&W television 9 villages (Bandergog, Pithagog, Markang, Barkasarang, Marlap, pessamsaru, Dondorai, Magurchilla, Kolongpar) in Sonapur Circle, Kamrup district 1996	9 lighting systems 8 Non-functional 9 portable B&W televisions 7 non-functional	Technical specifications Module 2 nos, 35 Wp per system Luminaire 2 nos, 7W CFL per system Battery 12 V, 40 Ah Benefits/problems ▪ To provide lighting for the community hall and run televisions for entertainment ▪ Non-functional televisions suffer from problem in the internal circuit ▪ Modules and batteries in working condition ▪ Some of the luminaires have been removed for replacement in individual homes, remaining are either fused or blackened Rectification ▪ New luminaries and repairs in televisions required

Table 2.10 Electrification of Tarabari village in Kamrup district
[NEC (FIN)/ 1-25/92-93/99, 16.03.1993]
Implementing agency Bosco Reach Out, Guwahati

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lanterns (Independent charging type) Tarabari (16) Chigandi (9) 1993	25 Non-functional	Technical specifications Module 1 no, 9 Wp per system Luminaire 6 W CFL Battery 2 nos, 6V, 6Ah, per system Benefits/problems ▪ Systems distributed for household electrification ▪ Lanterns were destroyed along homes during a hailstorm in 1994

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lanterns (Central charging type) Tarabari (80) Chigandi (55) 1993	135 Non-functional	Technical specifications Luminaire 6W CFL Battery 2 nos, 6V 6Ah, per system Benefits/problems • Lanterns were distributed to the households for the lighting purpose • Devices and systems missing after destruction during a hailstorm in 1994
Solar lantern collective charging station 1993	6 nos Non functional	Technical specifications Each station designed to charge 25 lanterns Benefits/problems • Only 2 stations were installed • Charging stations were destroyed in a hailstorm
Street light Tarabari (4) Chigandi (4) 1993	8 Non-functional	Technical specifications Module 2 nos, 30 Wp per system Luminaire 11W CFL Battery 12V, 60 Ah Benefits/problems • Streetlights were installed for public lighting • Systems missing after destruction during storms in 1994
Rice pounding unit Tarabari 1993	1 Non-functional	Technical specifications Modules 7 nos, 30 Wp Benefits/problems • Installed as a demonstration unit
SPV pump Tarabari 1993	1 Non-functional	Technical specifications Capacity: 4000 LPD Module 7 nos, 30 Wp Benefits/problems • To supply drinking water in the village
Solar UV water purifier Tarabari 1993	1 Non-functional	Technical specifications Capacity 6000 LPD Modules 6 nos, 30 Wp Battery 12V, 120 Ah Benefits/problems • Purifier was connected to SPV pump to provide potable water in the village

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
SPV rope/yarn spinning unit Tarabari 1993	10 Non-functional	Technical specifications Module. 15 Wp Battery Not available Benefits/problems ▪ Systems were installed to generate employment for villagers
SPV insect trap Tarabari 1993	2 Non-functional	Technical specifications Module 2 nos, 30 Wp Battery 12V Benefits/problems ▪ The system was used to trap insect for feeding the fish in the pond
SPV oil extraction unit Tarabari 1993	1 Non-functional	Technical specifications Capacity 300W, pedestal type unit Benefits/problems ▪ System became non-functional after two weeks of installation
Lighting for community center Tarabari 1993	3 indoor lights Non-functional 1 outdoor lights Non-functional 2 B&W television Non-functional	Technical specifications Modules 6 nos, 30 Wp Battery 12V, 120 Ah Benefits/problems ▪ To electrify the community hall and operate the television sets for entertainment

Rectification As indicated by the beneficiaries and the implementing agency, all the systems described above were damaged / destroyed by a hailstorm in April 1994 At present, there is no trace of any systems/devices at their original sites However, 6 SPV modules and 3 batteries are kept in the local school teacher s house to operate a tape recorder To revive the scheme, new systems have to be installed

Note Under this scheme, a micro hydel system and improved chulhas were also installed These are described in chapters 4 and 5, respectively

Scheme SPV devices in 20 remote hospitals in Assam

[NEC/RRE/283/97-98/55, 27.03.98]

Implementing agency: Energy Division, ASTEC (Assam Science, Technology and Environment Council), Guwahati

The scheme is yet to be implemented by ASTEC, Guwahati.

Manipur

Table 2.11 Electrification of 4 villages by SPV system [NEC (FIN) 1-33/87-88/321, 16.03.1988]

Implementing agency: DSTE (Department of Science, Technology and Environment), Imphal

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Street and household electrification Soraphung village, Ukhrul district 1991	30 light points Non-functional 8 streetlights Non-functional	Technical specifications Modules 35 Wp Batteries 48V, 200 Ah Luminaire 1 no , 8W CFL per system Benefits/problems • To electrify households and for street lighting for four hours daily • System functional for one year after installation, but was damaged during a storm • All the batteries were damaged, and no luminaires were found at the site • System has been dismantled and modules are stored at the village headman's house Rectification • As all the modules are in working condition, the system can revived with installation of new batteries, luminaires and connecting wires
Street lighting system Sorbung village, Ukhrul district 1991	30 Non-functional	Technical specifications Modules 35 Wp Batteries 48V, 200 Ah Luminaire 1 no , 8W CFL per system Benefits/problems • To provide public lighting • System functioned for one year after installation Rendered non-functional owing to frequent problems in batteries • Batteries are damaged and luminaires do not work as a result of long periods of disuse • Connecting wires are missing • Most panels have been dismantled, however some are being used to operate a radio and a television set in the village Rectification • With new batteries, luminaire and connecting wires, system can be reinstalled as all the solar modules are functional and available

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Domestic and street lighting systems Yangkhullen village, Senapati district 1991	30 domestic light points Non-functional, 8 streetlights Non-functional	Technical specifications Modules 35 Wp Batteries. 48V, 200Ah Luminaire 1 no, 18W CFL Benefits/problems ▪ To provide street lighting and electrify households ▪ Batteries and luminaires are non-functional because of long periods of disuse All solar modules were damaged during a storm No trace of the systems at site Rectification ▪ Complete new installation required
Street lighting system Muktikullen village, Tamenglong dist 1991	30 Non-functional as stated by the implementing agency The site was not visited as per the advice of DSTE office owing to law and order problem	Technical specifications Modules 35 Wp Batteries 48V, 200 Ah Luminaire 1 no, 18 W CFL Centralized charging system Benefits/problems ▪ To provide public lighting in the village ▪ As indicated by the implementing agency, the system has been non-functional since last four years as all the parts were damaged during ethnic clashes in the village None of the components are available at the site

Table 2.12 Wind-cum-solar energy power supply at Konganthana village
[NEC (FIN) 91-92/ 77, 23.01.1992]
Implementing agency. DSTE (Department of Science, Technology and Environment), Imphal

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar PV and aerogenerator Konganthana village 1995	1 Non-functional as indicated by the Block Development Officer, Kamjong block Site not visited as advised by the implementing agency owing to law and order problems	Technical specifications Not available Benefits/problems ▪ To electrify the village

Meghalaya

Table 2. 13 Electrification of Rambigin Village [NEC (FIN) 1-25 / 95-96/27, 20 10.95]
Implementing agency MNREDA (Meghalaya Non-conventional and Rural Energy Development Agency), Shillong

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
Solar Lantern Rambigin village, East Garo Hills district 1996	18 Non-functional	*Technical specifications* Module 1 no 10 W per system Luminaire 1 no , 7 W CFL *Benefits/problems* • For electrification of households • Batteries, luminaires and electronic circuit were found to be damaged *Rectification* • New lanterns to be installed
Streetlight Rambigin village East Garo Hills district 1996	5 Non-functional	*Technical specifications* Module 2 nos , 35 Wp per system Luminaire 1 no , 11 W CFL *Benefits/problems* • For public lighting in the village • Modules in working condition, luminaire as well as batteries damaged *Rectification* Luminaires and batteries to be installed

Table 2.14 2.5 kW SPV power plant [NEC (FIN)/1-25 /89-90/102, 27/10/1989]
Implementing agency MNREDA (Meghalaya Non-conventional and Rural Energy Development Agency), Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar power plant Maullien, village, Jaintia Hills dist 1991	1 power plant for 45 domestic lighting devices (households), 18 streetlights Non-functional	*Technical specifications* Capacity 2.5 kW Battery 24 nos, 12 V, 400 Ah Module 84 nos, 35 Wp Luminaire, domestic light 9 W CFL, Street light 11 W CFL *Benefits/problems* • For household and street lighting • Electronic charge controller was shifted from the site after it became non-functional in 1995, and transmission wires were missing • Batteries were completely damaged • In some households luminaires were damaged • Nine modules were stolen from the site in 1996, remaining are in working condition *Rectification* • Replacement of batteries and electronic parts

Table 2.15 Electrification of two villages in Meghalaya (NEC/RRE/282/97-98/63, 27/3/98)

Implementing agency: MNREDA (Meghalaya Non-conventional and Rural Energy Development Agency), Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar power plant Belgiri, West Garo Hills Nongpyrdi, East Khasi Hills 1999	2 (1 power plant per village for 45 domestic lighting devices and 5 streetlights) Functional	*Technical specifications per plant* Capacity 2 kW Module 56 nos, 37 Wp Battery 24 nos, 48 V, 600 Ah Inverter output: 3 phase line, 16 A, 240 V AC Luminaire domestic light 9 W CFL, street light 20 W FL *Benefits/problems* • For electrification of the village (households and street lighting) • Society comprising beneficiaries was formed to maintain the SPV devices • Beneficiaries pay Rs 10/- per month for maintenance of the system • Adjustable timer has been designed in the power packs to provide lighting for six hours daily from 5 to 11 pm

Table 2.16 Solar energy in Umdang Village [NEC (FIN)/1-25/92-93/98, 10 03.93]

Implementing agency. Khasi Jaintia Presbyterian Synod, Shillong

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, Rectification*
Solar Lantern (centralised charging) Umdang village West Khasi Hills district 1993	130 Non-functional	*Technical specifications* Luminaire 1 no, 16 W per system Battery 12V, 10 Ah *Benefits/problems* • Lanterns were distributed to electrify every household • Problems encountered with batteries, circuit, and luminaire *Rectification* • New lanterns required

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, Rectification
Central charging stations *Umdang village, West Khasi Hills district* *1993*	*5* *Non-functional*	*Technical specifications* *Module 12 nos 30 Wp per station* *Benefits/problems* ▪ *To charge solar lanterns (10 lanterns were charged at a time at each station)* ▪ *Modules of three stations were missing (according to the users, these were either stolen or taken away) The functional modules of the remaining two stations were dismantled, and are being used in some households to run a television and for lighting* *Rectification* ▪ *The modules in use by the households can be assembled together to set up a charging station with a smaller number of SPV lanterns* ▪ *New modules required to replace the missing ones*
Street lights *Umdang village West Khasi Hills district* *1993*	*10* *Non functional*	*Technical specifications* *Module 2 nos, 35 Wp per system* *Luminaire 1 no , 11W CFL* *Battery 12V, 120 Ah* *Benefits/problems* ▪ *Streets lights were installed for public lighting* ▪ *All systems were dismantled and stolen* *Rectification* ▪ *New installations required*
SPV rice pounding unit *Umdang village, West Khasi Hills district* *1993*	*1* *Non-functional*	*Technical specifications* *Prime mover 250 W* *Module 2 nos, 30Wp* *Battery 12V, 60Ah* *Benefits/problems* ▪ *System was a demonstration unit but did not function during installation* ▪ *Modules were stolen from the site* *Rectification* ▪ *New system to be installed*

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, Rectification
Solar powered oil extraction unit *Umdang village, West Khasi Hills district* *1993*	*1* *Non-functional*	*Technical specifications* *Screw type oil expeller* *Module 3 nos, 30Wp* *Battery 12V, 90Ah* *Motor 250 W* *Benefits/problems* ▪ *System was demonstration unit but stopped function soon after installation* ▪ *Modules and entire expelling unit including motor are missing* *Rectification* ▪ *New system to be installed*
Solar water purifier *Umdang village, West Khasi Hills dist.* *1993*	*1* *Non-functional*	*Technical specifications* *Module 1 no., 30Wp* *Capacity 6000 litre/day* *UV quartz radiation chamber* *Benefits/problems* ▪ *To provide potable water to the villagers* ▪ *Entire system missing* *Rectification* ▪ *New system to be installed*
Solar still *Umdang village, West Khasi Hills dist* *1993*	*2* *Non functional*	*Not installed as indicated by the villagers*
Solar powered OHP *Umdang village, West Khasi Hills dist* *1993*	*1* *Non functional*	Not installed as indicated by the villagers
Solar PV powered community hall *Umdang village, West Khasi Hills dist* *1993*	*2 B/W televisions* *4 indoor lights* *1 Public address system* *Non-functional*	*Technical specifications* *Module 6 nos, 30Wp* *Battery 12V, 180Ah* *Luminaire 1 no , 9W CFL* *Benefits/problems* ▪ *Hall used for public functions and entertainment* ▪ *Televisions taken away by KJP Synod because of non-transmission* ▪ *Modules are missing (stolen from the site* ▪ *luminaire damaged* *Rectification* ▪ *New system to be installed*

Table 2. 17 Electrification of three villages in Meghalaya
[NEC(FIN)/1-33/96-97/03, 17.04.1996]
Implementing agency. Khasi Jaintia Presbyterian Synod, Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status *	Technical specifications, benefits/problems, rectification
Solar lantern Pala village, Jaintia Hills Rngibah village, East Khasi Hills Mawliehpoh village, West Khasi Hills 1997	334 Pala (126) Rngibah (143) Mawliehpoh (65)	Technical specifications Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL Benefits/problems • For electrification of the households
Solar street lights Pala, Jaintia Hills Rngibah, East Khasi Hills Mawliehpoh, West Khasi Hills 1997	45 (15 nos in each village)	Technical specifications Module , 2 nos 35 Wp per system Luminaire 1 no , 20 W FL Battery 12 V, 75 Ah Benefits/problems • For public lighting in the village
Rice pounding Unit Pala, Jaintia Hills Rngibah, East Khasi Hills Mawliehpoh, West Khasi Hills 1997	3 (1 no in each village)	Technical specifications Prime mover 120 W Module 2 nos, 30Wp Battery 12V, 60Ah Benefits/problems • System installed for pounding rice and turmeric

* Could not be evaluated because of logistical constraints, however KJP Synod had indicated that all the systems were functional up to 1998 and presently only a few systems are functional

Table 2. 18 Electrification of six villages in Meghalaya
[NEC/RRE/282/97-98/57, 27.03 1998]
Implementing agency· Khasi Jaintia Presbyterian Synod, Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern 6 village in three districts 2000 Nongrim, East Khasi Hills (81) Belahari, Ribhoi district (53) Wahsarang, Jaintia Hills (165) Muthlongr, Jaintia Hill (50) Nongjri, West Khasi Hill (80) Nongpriang, West Khasi Hill (51)	480 (For breakdown see the first column) Functional	Technical specifications Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL Benefits/problems • For electrification of the households

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar street lights 6 village in three districts 2000 Nongrim,East Khasi Hills (3) Belahari, Ribhoi district (2) Wahsarang, Jaintia Hills (5) Muthlongr, Jaintia Hill (2) Nongjri, West Khasi Hill (3) Nongpriang, West Khasi Hill (2)	17 Functional	Technical specifications Module , 2 nos , 35 Wp per system Luminaire 1 no , 20 W FL Battery 12 V, 75 Ah Benefits/problems • For public lighting in the village

Table 2. 19 Installation of 3x2 kW SPV grid hybrid power pack in KJP Synod Hospital [NEC/ RRE/282/97-98/58, 27.03.98]

Implementing Agency: Khasi Jaintia Presbyterian Synod, Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Dual bank hybrid solar/grid integrated power pack KJP Synod Hospital, Jowai 1999	4 Partly functional	Technical specifications per system Module 10nos , 35 Wp Battery Lead acid rechargeable sealed Luminaire 20 FL (20 W) Others Major and Minor OT lights Benefits/problems • Electricity supply to the OT and hospital during power cuts • Two FL are non-functional because of luminaire breakage • The installed systems do not meet the original system specification sanctioned by NEC Rectification • Luminaire needs to be replaced

Table 2.20 Installation of SPV lanterns and street lights in 15 remote villages [NEC (FIN)/1-33/96-97/160, 06 02 1997]

Implementing agency. Biate Tribal Social Welfare Organisation, Jowai

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern 27 villages of Saiphung area, Jaintia Hills district 1997 Thuruk (69), Khoingoi & Singlei (28) Kulpui (58), Saron (16), Mualhoi (26), Tlangpui (10), Saibual (40), Tuidam (37), Saphak (16), Jongna New (7), Singlei (4) Teizol (10), Tlangmoi (14), Jongna Lui (13) Tuituk (21), Situng (9) Ngaibang (12), Khoingoi (15), Sialkan (19) Saitual (9), Laizal (16) Nachangzol (16), Disamatung (15), Diruphai (7), Kaizakam (22), Fiangpui (14) and Mualcheng (14)	537 Households 507 and Church 30 (For complete breakdown refer the first column) 201 functional 336 non functional	*Technical specifications* Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL *Benefits/problems* • For electrification of the households and village level church • In the non functional systems, batteries, luminaire and electronic circuit were found to be damaged *Rectification* • Damage batteries and luminaries require replacement
Solar street lights 6 villages of Saiphung area, Jaintia Hills district 1997 Thuruk (15) Kulpui (19) Saron (4) Mualhoi (3) Tlangpui (3) Saphak (1)	45 15 functional	*Technical specifications* Module , 2 nos , 35 Wp per system Luminaire 1 no , 20 W FL Battery 12 V, 75 Ah *Benefits/problems* • For public lighting in the village • Non functional systems suffers from luminaire and battery damage • Modules of some of the non-functional systems are in working condition *Rectification* New luminaire and batteries to be installed

Table 2. 21 Electrification of Mualsei village, Jaintia Hill district [NEC (FIN)/1-33/95-96/263, 25/3/96]

Implementing agency Biate Tribal Social Welfare Organisation, Jowai

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern Mualsei village, Jaintia Hills district 1996	134 (Households 127 Institutions 7) 24 functional 110 non functional	*Technical specifications* Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire· 7 W CFL *Benefits/problems* • For household and institutional electrification • Batteries, luminaire and electronic circuit were found to be damaged *Rectification* Replacement of batteries and luminaries

Solar street lights Mualsei village, Jaintia Hills district 1996	24 4 functional	*Technical specifications* Module , 2 nos , 35 Wp per system Luminaire 1 no., 20 W FL Battery: 12 V, 75 Ah *Benefits/problems* ▪ For public lighting in the village ▪ Luminaire and battery damage. *Rectification* ▪ New luminaire and batteries to be installed

Table 2.22 Electrification of two villages in Meghalaya [NEC/RRE /282/97-98/59, 27/3/98]

Implementing agency: Bosco Reach Out, Meghalaya Desk, Shillong.

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern Khamg and Kongthong, village East Khasi Hills district 1999	158 Khrang (73) Kongthong (85) 12 non functional 146 functional	*Technical specifications* Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL *Benefits/problems* ▪ For electrification of the households ▪ Lantern used for three hours daily ▪ Defective switches and deep discharged batteries in non functional systems *Rectification* ▪ Discharged batteries requires proper charging and damaged switches require replacement

Mizoram

Table 2 23 Installation of 15 Nos of street lights at Presbyterian Hospital [NEC/RRE /282/97-98/62, 27/3/98]

Implementing Agency: Presbyterian Hospital, Durtlang, Aizawl

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
SPV Street lights Presbyterian Hospital, Durtlang, Aizawl 1998	15 Functional	*Technical specifications* Module , 1 no , 70 Wp Luminaire 1 no , 11 W CFL Battery 12 V, 120 Ah *Benefits/problems* ▪ Lighting for pathways in the hospital complex ▪ Regular maintenance undertaken by the hospital staff Annual Maintenance Contract has also been signed with a local agency

Table 2. 24 SPV streetlights and lanterns at AGAPE complex
[NEC (FIN)/1-33/97-98/20; 20.05.1999]
Implementing Agency· Society for Community Care Dawrpui Pastorate, Aizawl.

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar street lights AGAPE Complex Aizawl 1997	10 8 functional	Technical specifications Module , 70 Wp Luminaire 1 no., 11 W CFL Battery 12 V, 120 Ah Benefits/problems ▪ For lighting the church complex ▪ Battery of the one system was found to be missing and luminaire of the other was broken Rectification ▪ Replacement of the battery and luminaire
Solar lantern AGAPE Complex Aizawl 1997	50 Church 20 nos 18 functional Church members 30 nos Functional	Technical specifications Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL Benefits/problems ▪ For electrification of the church and the members' households ▪ Battery of two systems was deeply discharged Rectification • Proper charging of the battery

Table 2.25 Electrification of 20 nos. of Churches in remote villages
Implementing Agency· Power & Electricity Dept, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern 20 churches, 3 lantern per church 1997 Kawhzai (6) Darngawn (6) Thekpui (6) Thekte (6) Thaidawr (3) Pathiantlang (6) Kanghmun (9) Bawlte (6) Darlung(6) South Sabual (6)	60 (For breakdown of system refer to first column) 27 evaluated Non functional	Technical specifications Module , 1 no , 10 Wp Luminaire 1 no., 7 W CFL Battery 12 V, 7 Ah Benefits/problems ▪ For electrification of the churches ▪ Systems ceased to function after one year of operation Lanterns dismantled with parts missing or entire systems are missing ▪ In some churches, modules are being used to power public address system. Rectification ▪ New installation required

Table 2.26 Electrification of Parva village [NEC (FIN)/1-33/95-96/260; 25.03.1996]
Implementing Agency: Power & Electricity Dept, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices Present functional status *	Technical specifications, benefits/problems, rectification
Solar lantern Parva village West Chimtuipui district 1997	160	Technical specifications Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL Benefits/problems ▪ For electrification of the households
Solar street lights Parva village West Chimtuipui district 1997	10	Technical specifications Module , 70 Wp Luminaire 1 no , 11 W CFL Battery 12 V, 120 Ah Benefits/problems ▪ For public lighting in the village

* Could not be evaluated because of logistical constraints

Table 2.27 Electrification of Selam village [NEC (FIN)/1-33/96-97/78, 13 03.1997]
Implementing Agency: Power & Electricity Department, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lantern Selam village Ngopa block, Aizawl East district 1997	140 30 functional	Technical specifications Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL Benefits/problems ▪ For electrification of the households
Solar street lights Selam village Ngopa block, Aizawl East district 1997	7 2 functional	Technical specifications Module . 70 Wp Luminaire 1 no . 11 W CFL Battery 12 V, 120 Ah Benefits/problems ▪ For public lighting in the village

Table 2.28 Electrification of Hnangmun village, [NEC (FIN)/1-25/95-96/55, 26 02 96]

Implementing agency Power and Electrical Department, Govt of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems rectification
Solar lantern Hnangmun village Ngopa block, Aizawl East district 1996	70 Could not be evaluated because of logistical constraints	*Technical specifications* Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL *Benefits/problems* • For electrification of the households

Table 2 29 Electrification of four villages in Mizoram (NEC/RRE/282/97-98/61, 27/3/98

Implementing agency Mizoram Renewable Energy Development Agency, Aizawl

Device, system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lanterns Fung kah village, Rawlbuk Village Vertek village, Vartekkai Tuipui village	140 Functional	*Technical specifications* Module 10 Wp per lantern Battery 12 V, 7 Ah Luminaire 7 W CFL *Benefits/problems* • For electrification of the households
Solar street lights Fung kah village, Rawlbuk Village Vertek village, Vartekkai Tuipui village	12 Functional	*Technical specifications* Module , 70 Wp Luminaire 1 no , 11 W CFL Battery 12 V, 120 Ah *Benefits/problems* • For public lighting in the village

Tripura

Table 2. 30 Employment generation for tribal youths through solar lantern [NEC (FIN) 91-92 77, 23.01.1992]
Implementing agency: NB Institute of Rural Technology, Agartala

Device/system Location Date of distribution	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
Training of 100 tribal youth from different north-eastern states The following items were distributed to trainees: Solar lantern, tool box, PV module and module frame The training was organised at four locations: Agartala, Itanagar, Imphal and Guwahati 1992	100 sets Functional	*Technical specifications* Module 1 no , 35Wp per system Charger Plastic body with two charging points Luminaire 1 no , 9W per system Battery. 2X 6V, 10Ah *Benefits/problems* • The objective of the project was to train tribal youths to set up business with solar lanterns by renting them in their respective villages • Feedback from the trainees was positive, followed by demand for more such lanterns

3 Solar thermal schemes

The use of power of sun for heating, drying and evaporation is well known, and various applications of solar thermal energy such as solar water heating system (SWHS), solar still for distilled water, solar cooker and solar passive building are being promoted in the north-eastern region

A SWHS consists of solar flat/parabolic collector and a storage tank connected with collector through the insulated connecting pipes for supply of hot water A typical commercially available solar water heater has a capacity of 100 LPD (litre per day), but the capacity can be designed up to thousands of litres Such systems are not only useful for domestic purposes but also for various industries utilizing hot water, such as oil expelling units, micro- dyeing units and dairy industry Since most of these industries use diesel or biomass as fuel, the use of SWHS can lead to savings in the fuel consumption

Solar stills are devices used for production of distilled water The capacity of such stills ranges from 1-2 LPD Solar cookers are being popularised for cooking food (boiling and baking mainly) without using conventional fuel The principle on which the system works is based on the absorption of the solar thermal energy This system is ideally suited for a family size of 4-5 persons and consists of four metal pots inside an insulated box lined with a black polished metal sheet Currently, two types of systems are available in the market with electrical back-up and without electrical back-up

Solar building, is an architectural concept of tapping the solar heat energy inside a building structure There are two primary categories into which virtually all solar heating systems may be divided The first is passive systems, in which solar radiation is collected by some element of the structure itself, or admitted directly into the building through large south facing windows The second is the active systems, which generally consist of separate solar collectors that may heat either water or air.

Implementation of solar thermal schemes

Under the NEC Plan, several solar thermal application schemes have been executed in the northeastern states. Nearly all the schemes have been implemented by the state nodal agencies In Manipur, all the schemes were

implemented by DST&E (Department of Science Technology and Environment), which had sub-contracted the implementation to *Manitron* (Manipur Electronics Development Corporation*)*. The maintenance of the systems was initially undertaken by *Manitron*, which later became the responsibility of the DST&E. In Meghalaya, systems were installed by state nodal agency MNREDA, Shillong and the Rama Krishna Mission, Cherrapunjee. In Mizoram, the IREP Cell of the Department of Power and Electricity, Govt. of Mizoram has implemented such schemes. The Department of Power and Electricity also disseminated solar water heaters in two local hospitals in Aizawl.

Functional status of solar thermal schemes

Solar water heating systems comprise the main application of solar thermal energy in northeastern region. Twenty-five solar thermal schemes were evaluated, of which only nine systems were found to be functional. In Mizoram all the installed systems were found to be functional The major factor responsible for the non-functionality is the lack of knowledge of maintenance and operation of such systems. Almost all the non-functional systems suffered from common problems of improper insulation of the pipe, storage tank and choking of solar collectors. Despite the low functional rate of the water heating systems, there is a demand for these systems as the technology has proved to be beneficial as an energy saving option. The solar hut proposed in Tawang district, Arunachal Pradesh is yet to be commissioned by the APEDA (Arunachal Pradesh Energy Development Agency), Itanagar.

Systems that were assessed, are being used in agro-processing and micro-dyeing industries and hospitals. In hospitals, hot water is being supplied to kitchen, operation theatre and wards The installed SWHS are able to provide hot water almost throughout the day In case of the oil-expelling unit, hot water was used as boiler feed to generate steam The use of solar heater brought about an average savings of 50-60 kg of wood per day to heat the water till 60°C - 70°C along with timesaving In case of micro-dyeing industry, water temperature of 70°C - 80°C could be obtained from the SWHS during clear sunshine days Thus, the benefits of SWHS are very obvious but the systems require proper operation and regular maintenance Details of the performance of schemes that have been evaluated in different states of northeastern states are as follows.

Table 3.1 Status of performance of solar thermal schemes under NEC Plan

State	No of systems	No of systems evaluated	To be commissioned	Functional	Non-functional
Arunachal	2	2	1	0	1
Manipur	14	14		2	12
Meghalaya	4	4		1	3
Mizoram	6	6		6	0
Grand total	26	26	1	9	16

Arunachal Pradesh

Table 3.2 Solar Hut at Tawang [NEC (FIN)/1-25/90-91/36, 19.07.1990]

Implementing Agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hut Tawang township, Tawang district	1 To be constructed	Technical specifications The site for the hut has been selected, however construction is yet to be initiated Benefits/problems ▪ To demonstrate the use of solar passive architecture as a energy conservation measure in cold regions

Table 3.3 Renewable energy system in VKV Oyan [NEC (FIN) 1-25/92-93/97,10.03.92]

Implementing agency: Vivekananda Kendra Shiksha Prasar Vibhag, Dibrugarh

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system VKV campus 1993	1 Non-functional	Technical specification Capacity 200 litre/day Benefits/problems ▪ Supply of hot water to hostel inmates ▪ System has been dismantled, owing to lack of shadow-free site Rectification ▪ System can be reinstalled in a suitable site receiving sufficient sunshine

Manipur

Table 3.4 1000 LPD Solar hot water system [NEC (FIN)/1-25/84-85/67, 23.01.1985]

Implementing agency: Regional Institute of Medical Sciences, Imphal

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system RIMS, Imphal 1990	1 Non-functional	*Technical specifications* Capacity 1000 LPD Collectors 8 nos per system, 2 m^2 area Design temp. 60 ^{0}C *Benefits/problems* ▪ To provide hot water to the operation theatre ▪ The system was dismantled in1995 because of construction of a building at the site where the system was installed. ▪ Currently all the collectors are broken and are stored in the hospital. Only six-glass covers were found at the store Piping and storage tank have been damaged *Rectification* ▪ New installation required

Table 3.5 Solar thermal systems in Manipur [NEC (FIN)/1-25/88-89/167, 14.03.89]

Implementing agency: DSTE (Department of Science, Technology & Environment), Govt. of Manipur, Imphal

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar water heater J N hospital, Imphal 1992	4 3 Non-functional	*Technical specifications* Capacity 1000 LPD per system Collectors 8 nos per system, 2 m^2 area Design temp 60 ^{0}C *Benefits/problems* ▪ To provide water for kitchen, OT, casualty and male surgical ward ▪ Two systems were dismantled from the site during the renovation of old hospital building ▪ One system is non-functional Its connecting pipes were damaged and two collectors were also broken *Rectification* ▪ Dismantled systems can be reactivated after minor repairs ▪ Non functional system requires new connecting pipes and collectors for revival

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar water heater District Hospital, Churachandpur Dist 1991	2 Non-functional	Technical specifications Capacity 1000 LPD per system Collectors 8 nos per system, 2 m^2 area Design temp 60 ^{0}C Benefits/problems • To provide water for kitchen, OT, and casualty • Out of16 collectors, eight were severely damaged in a hailstorm and the remainder were stolen Rectification • New installation required
Solar water heater Manipur agro-industries, Imphal 1991	1 Functional	Technical specifications Capacity 1000 LPD Collectors 8 nos per system, 2 m^2 area Design temp 60 ^{0} C Benefits/problems • To supply hot water as boiler feed for steam generation
Solar water heater Police Training Centre, Imphal 1991	2 Non-functional	Technical specifications Capacity 1000 LPD per system Collectors 8 nos per system, 2 m^2 area Design temp 60 ^{0}C Benefits/problems • To supply hot water for bathing to resident cadets • Collectors are choked • One collector, each in both the systems was broken Rectification • Revival possible with replacement by new connecting pipes, collectors and storage tank
Solar water heater Manipur Rifles, Tamenglong district HQs 1991	1 Non-functional	Technical specifications Capacity 1000 LPD per system Collectors 8 nos per system, 2 m^2 area Design temp 60 ^{0}C Benefits/problems • To provide hot water for drinking to the cadets • System was damaged in a storm a year after it was installed • Collectors have been dismantled and stored away. Rectification • One collector, connecting pipes and the storage tank need replacement

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar water heater Micro-dye house, Imphal 1991	1 Non-functional	Technical specifications Capacity 1000 LPD Collectors 8 nos per system, 2 m^2 area Design temp 60 °C Benefits/problems ▪ To provide hot water during the dyeing process ▪ All collectors were damaged in a storm, after six months of operation Rectification ▪ New installation required
Solar Water Heater Hotel Imphal Ashok, Imphal 1991	2 Non-functional	Technical specifications Capacity 1000 LPD per system Collectors 8 nos per system, 2 m^2 area Design temp 60 °C Benefits/problems ▪ To provide hot water for the hotel staff premises ▪ One collector each, in both the systems and piping were found damaged ▪ Storage tank is disconnected from the system Rectification ▪ Two collectors, connecting pipes and storage tank need to be replaced to revive the system

Meghalaya

Table 3.6 5000 LPD solar hot water system [NEC (FIN)/1-25/89-90/103, 27.10.1989]

Implementing agency: MNREDA (Meghalaya Non-conventional and Rural Energy Devt Agency), Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system Orchid Lake Resort, Barapani 1992	1 Non-functional	Technical specifications Capacity 5000LPD Collector 10 nos, 2 m^2 area Electric back-up Benefits/problems ▪ To provide hot water for guestrooms and kitchen ▪ At the time of commissioning, rooms were yet to be constructed so water was supplied to the kitchen only ▪ System became non-functional in 1993 because of lack of proper maintenance ▪ Collectors and connecting pipes are damaged Rectification ▪ At present guest rooms are fitted with electric geysers ▪ Damaged collectors and pipes need replacement ▪ System can be revived and installed elsewhere

Table 3.7 2 x 500 LPD Solar hot water system [NEC (FIN)/1-25/88-89/74, 22.08.1989]

Implementing agency Ram Krishna Mission Ashram, Cherrapunjee

Device/system Location Year of Installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system RK Mission Ashram, Cherrapunjee 1989	1 Non-functional	Technical specifications Capacity 500 LPD Collectors 5 nos, 2 m^2 area Electric back-up (3 kW) Benefits/problems ▪ To supply hot water to hostel inmates ▪ Functional till December 1996 ▪ All collectors were damaged in a storm and connecting pipes are corroded Rectification ▪ New installation required

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water heater R K Mission Girls' hostel Sohbarpunjee 1989	1 Non-functional	Technical specifications Capacity 500 LPD Collectors 5 nos, 2 m ^{2} area Electric back-up (3 kW) Benefits/problems ▪ To supply hot water to hostel inmates ▪ Functional till 1992, all collectors and connecting pipes are damaged Rectification ▪ New installation required

Table 3.8 Installation of 7500 LPD SHWS [NEC/ RRE/282/97-98/58, 27.03.98]

Implementing agency. Khasi Jaintiya Presbyterian Synod, Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system KJP Synod Hospital, Jowai 1999	1 Functional	Technical specifications Capacity 7500LPD Collector 36 nos, 2 m ^{2} area Design tem 60 ^oC Electrical back-up and pump Benefits/problems ▪ Has only one single user point, with supply to laundry and nursing station ▪ Low outlet temperature (about 45 ^{o} C) because of damaged insulation of the distribution pipe and absence of insulation at some part s of the pipe Rectification ▪ The damaged insulation needs to be replaced for better functioning of the system

Table 3.9 5000 LPD solar hot water system at Presbyterian Hospital
[NEC(FIN)/1-33/95-96/142, 14.12.1995]
Implementing agency· Department of Power & Electricity, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
Solar hot water system Durtlang, Aizawl 1997	1 Functional	*Technical specifications* Capacity 5000 LPD Collector 100 nos, 2 m^2 area Design temp 80 °C, Electrical back-up and pump *Benefits/problems* ▪ Supply of hot water to kitchen, laundry and OT Meets about 65% of hospital's hot water requirement ▪ Hot water temperature reaches about 90 °C ▪ Firewood savings worth Rs 15 000 per month achieved

Table 3 10 Solar Water Heating System at Greenwood Hospital
[NEC (FIN)/1-33/96-97/103, 30.10.1996]
Implementing agency· Greenwood Hospital Society, Aizawl

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
Solar hot water system Aizawl 1996	1 Functional	*Technical specifications* Capacity 1000LPD Collector 15 nos, 2 m^2 area Design temp 80 °C, Electrical back-up and pump *Benefits/problems* ▪ Supply of hot water to kitchen, nursing station and OT Meets about 80% of hospital s hot water requirement ▪ LPG savings of about 30-35 cylinders per month achieved

**Table 3.11 Solar hot water systems at Charity Homes [NEC (FIN)/1-25/96-97/79, 14.3.97]
Implementing agency: Department of Power & Electricity, Govt. of Mizoram, Aizawl**

Device/system Location Year of installation/commissioning	*Number of devices* *Present functional status*	*Technical specifications, benefits/problems, rectification*
Solar hot water system Motherless Babies Home, Aizawl. 1997 Vocational Training Centre, Mualpui , 1997 Boys Home, Mualpui , Aizawl. 1997 Integrated School and Home for the Blind, Kolasib 1998	4 (1 in each charity home) Functional	*Technical specifications* Capacity · 250LPD Collector: 2 nos, 2 m^2 area Design temp. 80 °C, *Benefits/problems* • Hot water supply for bathing and to kitchen

4 Hydro schemes

Small hydro has emerged as a significant source of power among the renewables in context of decentralized power generation and the prevalent hilly topography in the northeastern region The region is endowed with rich hydropower resources with the highest potential in Arunachal Pradesh Moreover being economically viable and environment friendly, efforts have been made to popularise this technology, through mini-micro systems and modified watermills

Hydro power is generated if water falls or is led from a higher level to a lower level, and the resulting flow of water can be used to do some work Normally a pipe (or penstock) is used to lead the water down a slope, and the results in a flow of water under pressure. If the water is allowed to move some form of turbine, then the pressure is converted into mechanical power and can be used to drive a generator or a grain mill or some other useful device. A micro-hydro system usually consists of two components 1 civil works mainly consists of weir or dam, intake, settling tank, channels, forebay tank, penstock, and powerhouse, and 2 electro-mechanical parts comprising turbine, alternator, governor, and transmission lines

The traditional watermills are fabricated locally with small timber These consist of a vertical shaft with the runner at the bottom consisting of wooden blades The runner, which is the heart of the unit, is a modified power production unit (MPPU) It is basically a low head impulse wheel of the *Pelton* type Water flowing in streams is diverted and directed through open flumes into the runner, which rotates the shaft. A pair of grinding stones, hewn locally, is fitted at the top end of the shaft, acts as the grinding mill. Grain for grinding is placed in a hopper, where the vibration transmitted from the grinding stones into the grain hopper regulated the flow of grain into the grinding stones.

Implementation of hydro schemes

Under the NEC funded schemes, 13 watermills in Arunachal Pradesh and 16 micro hydro systems within the Northeastern region were sanctioned. Of these, 11 systems are in Arunachal Pradesh, 1 in Assam, 3 in Mizoram and 1 in Nagaland The present evaluation study covered all the watermills and micro

hydro systems. In Arunachal Pradesh, APEDA is executing the watermills scheme, while the state Department of Power is responsible for the dissemination of micro hydro plants in different parts of the state. The installation of hydro systems is the responsibility of the Department of Electricity and Power in Mizoram. Likewise in Nagaland, Department of Power is the implementing agency. The only exception is the micro hydro system installed by an NGO (Bosco Reach Out) in Assam.

Functional status of micro hydro schemes

Under the watermills scheme, 13 traditional watermills were upgraded to MPPU (Modified Power Production Unit) The upgraded watermills would enhance the motive power for grinding and concurrently generate 1 to 3 kW of electricity during non-grinding periods. Till date, five MPPUs have been procured and four traditional watermills have been upgraded The remainder eight systems are yet to be procured and sites for installation is yet to be finalised For electricity generation an AC generator of 3 kVA with a control panel of 240-415V for power generation has been chosen.

The improved MPPU has enhanced the rate of grinding compared to the traditional system, but it has its limitations for power generation Efficiency in terms of power generation may decrease, as there would be a constant load, from the upper grinding stone. Improvement in the system by detaching the upper grinding stone mechanically would be desirable as physically removing a 1 m diameter/ 6" thick grinding stone would be cumbersome Constant physical removal and replacement would damage the placement groves, affecting grinding Most problems encountered are minor and can be rectified, but constant maintenance of the mills is required

In Arunachal Pradesh, the present scheme covers 11 micro hydro plants, ranging from 10 - 50 kW Out of these, five schemes have been completed and the six are under various stages of implementation. Most of the installations suffer from problems related to the design of the civil works, particularly the intake and the power channel The intake in most of the installations has been washed out, which is an indication that the design is not able to withstand the water force during peak periods Moreover the sediment load in the forebay is quite high This is mainly owing to the absence of de-siltation chambers in almost all the schemes This has not only reduced the capacity of the forebay, but also reduced the life of the turbines The overall performance status and detailed state-wise break-up of watermills and micro-hydro systems are as follows

Table 4 1 Functional status of micro-hydel systems under NEC plan (state-wise)

Implementing agency	Number of systems	Number of systems evaluated	to be commissioned	Functional	Non-functional
Arunachal Pradesh APEDA (watermills), Department of Power	24	24	15	4	5
Assam Bosco Reach Out	1	1	-	0	1
Mizoram Dept of Power & Electricity	3	3	1	2	--
Nagaland Department of Power	1	1	1	--	--
Grand Total	29	29	17	6	6

Arunachal Pradesh

Table 4.2 Development of 20 nos gharats in Arunachal Pradesh [NEC/1-25/94-95/3; 23.05.1994]

Implementing agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of systems /devices Present functional status	Technical specifications, benefits/problems, rectification
Rama Camp, West Kameng dist 1998	1 Functional	Technical specifications Stone diameter and thickness 1m/ 6" Open flume penstock pipe dia /length 6"/7 5m Head 3m Alternator 3kVA with control panel(240-415V) RPM on load 80 Benefits/problems ▪ System does not function as an electricity-generating unit ▪ No protection for lower thrust bearing Rectification ▪ Lower thrust bearing requires suitable protection such as cap made of metal or plastic ▪ Alternator can be downsized
Munna Camp West Kameng dist 1998	1 Non-functional	Technical specifications Stone diameter and thickness 0 30 m/ 6" Open flume penstock pipe dia /length 6"/6 5m Head 2.8 m RPM on load 60 Problems ▪ Defect in the stone key attachment ▪ Leakage of water into the thrust bearing Rectification ▪ Replace with new stone key attachment

Device/system Location Year of installation/commissioning	Number of systems /devices Present functional status	Technical specifications, benefits/problems, rectification
Salari village West Kameng dist. 1995	1 Functional	Technical specifications Stone diameter and thickness 0 30 m/ 6" Open flume penstock pipe dia /length.4"/6.5m Head. 2.9 m RPM on load.80 Problems • Leakage of water into the thrust bearing. • Detachment of the stone key from the runner shaft Rectification • Protection cover made of metal or plastic to avoid leakage • Tightening of the stone key hole by lining the shaft
Degchi Pam village West Kameng 1998	1 Functional	Technical specifications Stone diameter and thickness 0 57 m/ 6" Open flume penstock pipe dia /length 4"/6 3m Head 1 m RPM on load 80 Problems • Leakage of water into the thrust bearing Rectification • Protection cover made of metal or plastic to prevent leakage

Note Only four systems have been installed out of the total thirteen systems sanctioned under this scheme The remaining nine schemes are yet to be procured and the selection of suitable sites for installation is pending

Table 4.3 Mini micro-hydel scheme in 10 areas, capacities from 10 to 50 kW [NEC(FIN)/1-25/95-96/01, 08.05.1995]
Implementing agency Department of Power, Govt. of Arunachal Pradesh

Device/ system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
1 x 10 kW Thongleng village, Tawang district 1993	1 Non-functional	Technical specifications Head 100m Intake vertical wall on stream Penstock MS/HDPE Alternator 12 5 kVA Tailrace rectangular open channel Turbine Francis Benefits/problems ▪ To supply power to 70 households of Thongleng village, with a single light point connection ▪ System has been non-operational since the washout of the intake structure during floods in1994 ▪ No intake channel and forebay facilities Rectification ▪ Construction of a new intake structure
1 x 10 kW BTK Camp. Tawang district 1993	1 Non functional	Technical specifications Turbine Francis Benefits/problems ▪ To electrify 15 households of the labour camp ▪ Plant non-functional since May 1997, owing to breakdown in the runner shaft Rectification ▪ repair or replacement of the runner shaft Civil works, and other accessories are in working condition
1 x 10 kW Thimbu village, Tawang dist	1 Construction under progress (Site could not be visited because of logistical constraints)	Technical specifications Penstock HDPE Alternator 12 5 kVA Turbine Francis Benefits/problems ▪ Plant is located in one of the remotest areas of Tawang and is connected by a foot track Thus, almost all material related to civil construction and electro-mechanical equipment had to be airlifted from Jang, the nearest air base ▪ Plant in final stage of completion, with the installation of control panel pending

Device/ system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
1 x 30 kW Jigaon, West Kameng dist. 1996	1 Functional	Technical specifications Net head. 8 m Intake• flat inclined RCC plate towards power channel Penstock. MS sheet Alternator. 37 5 kVA Tailrace Closed trapezoidal Turbine Cross flow Benefits/problems ▪ Provide electricity to Jigaon village ▪ Generated 12 kW electricity till end of 199 ▪ Plant is partly functional because of leakag in turbine casing (currently stones are loaded over the turbine casing to prevent leakage) ▪ Back flow from the tailrace because of lowering of the turbine ▪ Designed head height not achieved Rectification ▪ Repair of turbine casing ▪ Lowering of the tailrace channel
1 x 50 kW Ankling village, West Kameng dist	1 Final selection of site pending	Technical specification Not available Remarks ▪ Construction of a power plant of much higher capacity is on the anvil in the vicini of the micro hydel site in Kalaktang. An alternative site can be identified for the micro hydel unit
1 x 10 kW Veo village, East Kameng dist	1 Construction under progress	Technical specification Not available Remarks ▪ The electro-mechanical equipment for the plant has been procured and installation awaited

Device/ system *Location* *Year of installation/commissioning*	*Number of devices/systems* *Present functional status*	*Technical specification, benefits/problems, rectification*
1 x 10 kW *18th Mile Camp, East Kameng dist*	*1* *To be commissioned*	*Technical specifications* *Head 15 m* *Penstock HDPE, 20 m* *Power channel 200 m* *Alternator 12 5 kVA* *Tailrace Closed conduit* *T&D Single Phase 2 km* *Turbine Francis* *Benefits/problems* ▪ *Installation of civil as well as electro mechanical equipment is complete, but the installation of the control panel, erection of the poles and extension of the local grid are awaited* ▪ *Water hammer effect in the penstock reported* ▪ *Discharge of the stream is adequate to run the plant to its full capacity* *Rectification* ▪ *Hammering effect can be removed by replacement of the penstock length with MS material or with other suitable material* ▪ *Defective HDPE penstock to be replaced by existing material or with MS sheet*
1 x 10 kW *Marjungla village, East Kameng district*	*1* *Non-functional*	*Technical specifications* *Head 18 m* *Intake flat inclined RCC plate towards power channel* *Penstock MS, 30 m* *Alternator 12 5 kVA* *Tailrace rectangular open channel* *T&D single phase 2 km* *Turbine Francis* *Benefits/rectification* ▪ *To electrify Marjungla and Khenwa villages* ▪ *Plant non-functional as a section of the power channel has been damaged, resulting in leakage* *Rectification* ▪ *Repair of the damaged section in the channel*

Device/ system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
1 x 30 kW Watte village, East Kameng dist. 1995	1 Non-functional	Technical specifications Head: 20 m Forebay:36.45 m^3 Penstock: MS, 50 m Alternator 37 5 kVA Tailrace: rectangular open channel Turbine: Francis Benefits/problems ▪ To electrify Watte-I (3 kW), Watte II (4 kW), Pampoli (15 kW), Wessang villages (3kW) ▪ The plant has become non operation owing to wash out of the intake structure during flash floods ▪ Lack of proper designing of the intake structure that can withstand flow of water Rectification ▪ Development of the intake is needed ▪ Construction of desiltation chambers with the power channel to avoid sediment load in the forebay
1 x 10 kW Patha village, East Kameng dist	1	Technical specification Turbine Francis Remarks ▪ Present site was identified in lieu of Rilo, which was selected earlier, as the discharge at Rilo could not provide the desired output ▪ Implementation awaited
1 x 50 kW Lada village, East Kameng dist	1	Technical specifications Turbine cross flow Remarks ▪ As reported by the implementing agency, survey and investigation of the site in progress However, the electro and mechanical equipment has been procured

Assam

Table 4.4 Electrification of Tarabari village in Kamrup district
[NEC (FIN)/ 1-25/92-93/99, 16.03.1993]
Implementing agency Bosco Reachout, Guwahati

Device/system Location Year of installation/commissioning	Number of systems Present functional status	Technical specifications, benefits/problems, rectification
Micro hydel Tarabari village, Kamrup district 1993	1 Non functional	Technical specifications Capacity 300 W Benefits/problems ▪ System was non functional since its commissioning

Mizoram

Table 4.5 Ramrilui Micro-hydel Scheme (2x150 kW)
[NEC(FIN)/1-33/91-92/310, 28/02/1992)]
Implementing agency. Department of Power & Electricity, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
2 x 150 kW Lungrang village Lunglei district 1997	2 Functional (Only one turbine operational)	Technical specifications Head 100m Intake vertical intake Design discharge 185 lit/second Penstock HDPE pipe, 450 mm dia, 362 m length Alternator 2 x 167 kVA Tailrace rectangular open channel Firm capacity 150 kW Turbine Pelton T & D 11 kV network Benefits/problems • To supply electricity to Lungrang, Rualalung, Bajeisora, Saijawl and Chawngte villages • One turbine non-functional since mid 1998 because of problems in the runner bearing Rectification • Replacement of the bearing

Table 4 6 Installation of 1x50 kW Vawralui microhydel project in Mizoram
[NEC(FIN)/1-33 / 91-92/353, 20.03.1992]
Implementing agency Department of Power & Electricity, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
1 x 50 kW Khawlian village, Aizawl East district 1997	1 Functional only in monsoon season	Technical specifications Head 42 m Intake vertical intake Design discharge 0 13 cumec Penstock HDPE pipe, 400 mm dia, 66 m length Altenator 1 x 62 5 kVA Tailrace rectangular open channel Turbine Francis T&D 11 kV network Benefits/problems • To supply electricity to Khawlian village • Owing to low discharge, the plant is operational only during the monsoons

Table 4.7 Leiva Micro Hydel Project (1x50 kW) [NEC(FIN)/1-25/93-94/45, 05/01/1994)
Implementing Agency: Department of Power & Electricity, Govt. of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
1 x 50 kW Kawlbem village, East Aizawl dist.	To be commissioned	Technical specifications Head.20 m Design discharge. 0.3 cumec Penstock: HDPE pipe, 350 mm dia, 47 8 m length Alternator: 1 x 62.5 kVA Tailrace rectangular open channel Turbine Francis T&D 11kV line Benefits/problems • To supply electricity to Kawlbem, Selam and Vaikhawthang villages • Plant in final stage of completion

Nagaland

Table 4.8 Duilumroi MHP (2x100 kW), [NEC (FIN)/1-25/93-94/53, 7.2.94]
Implementing agency: Department of Power, Govt. of Nagaland, Kohima

Device/system Location Year of installation/commissioning	Number of devices/systems Present functional status	Technical specification, benefits/problems, rectification
2 x 100 kW Near Poilwa and Dzulaki villages, Kohima district	1 To be commissioned after trial runs in February 1999	Technical specifications Power Channel 520m Forebay. 1 minute detention Penstock diameter 20" Length 150m Head 64m (net) Power house 8m x 5m Minimum discharge 0 40 cumec RPM load 1000 Energy output 0 52 MWh Benefits/problems • To supply power to Khonoma, Jotsoma, Mejoma, Setsoma villages, Science College and Forest Colony, Kohima • The civil work related to the power channel and the forebay is complete The plant will be commissioned after a test running of the plant during February 1999, and accordingly the date for commissioning would be finalised

5 Biomass technologies and IREP schemes

Biomass encompasses a wide variety of materials of plant or animal origin. Though this includes fossil fuels also, but generally, the term is used to cover renewable energy sources such as wood and wood waste, agricultural residues, animal and human faeces, all of which can yield useful fuels either directly or after some form of conversion The conversion process can be physical (for example, drying, size reduction or identification), thermal (as in carbonisation) or chemical (as in biogas production) The end result of the conversion process may be a solid, liquid or gaseous fuel This flexibility of choice in the physical form of the fuel is one of the advantages of biomass over other renewable energy sources The numerous biomass technologies being disseminated under the NEC schemes include improved cookstoves, biogas plants, energy plantations and gasifiers In addition, programmes such as Integrated Rural Energy Programme (IREP) are also being implemented under NEC schemes. IREP programmes entail implementation of area-based micro-level plans to tap in an integrated manner all types of energy sources with an optimum mix to meet the rural energy needs both for subsistence and productive purposes

Stoves that burn biomass fuels like firewood, agricultural waste and dried animal dung are called biomass stoves Most commonly these are known as cookstoves, woodstoves, or *chulhas* Biomass stoves are of two types traditional and improved Improved biomass stoves are an improvement over the traditional stoves in terms of higher efficiency, less smoke and lower fuel consumption An IC (improved cookstove) generally consists of a combustion chamber, air inlet and chimney Grate, damper and baffles are also incorporated in some stoves Stoves can be single or multi pot types. Most multi-pot stoves are fixed, but portable stoves made of ceramic or metal are also available.

Energy plantations are short rotation, high density, intensively managed plantations of fast growing tree and shrub species, specifically for the purpose of meeting the fuelwood requirements of the local people. They provide an effective way of satisfying the local energy requirements in a decentralised manner. The biomass obtained from the energy plantations may be directly converted into useful energy through direct combustion in cookstoves or for decentralised use through refined technologies such as pyrolysis, gasification, conversion into

liquid fuel, etc. This plantation can also be a useful tool for reclamation of wastelands and stabilising soil conditions.

Biogas is generated when any organic matter such as cowdung, crop residue, and kitchen waste is fermented in the absence of oxygen. Biogas contains combustible methane (around 60%) along with carbon dioxide, and traces of other gases. Biogas production is a chemical process occurring in stages during which different bacteria act upon the organic matter resulting in the formation of methane and acids A typical biogas plant has the following components. digester, an inlet tank, a gasholder, an outlet tank and distribution pipeline Various models of biogas plants are available. fixed dome, floating drum dome, *flexi* models, etc. In the Northeast the fixed dome models (*Deenbandhu* and *Janata*) are more popular than the other models.

Under controlled conditions of low oxygen supply and high temperatures, most biomass material can be converted into a gaseous fuel known as producer gas through gasifiers Producer gas consists of carbon monoxide, hydrogen, methane and nitrogen. This gas can be used for generation of motive power either in dual fuel engines or in ordinary diesel engines with some modifications. The gas can also be used for a variety of thermal applications including cooking, crop drying, process heat for different industries, vapour absorption cooling, etc. Thus, in all its applications, whether thermal or power generation, biomass gasification results in significant environmental benefit by partially or completely replacing the use of commercial energy sources.

Functional status of biomass and IREP schemes

Biomass and IREP schemes are being implemented in Arunachal Pradesh, Manipur, Assam and Meghalaya The respective state nodal agencies are executing these programmes. Almost all the installed improved cookstoves have exceeded their life or are damaged However, the users expressed satisfaction over the fuelwood savings brought about by these cookstoves. Fifty percent of the biogas plants installed under the IREP scheme at Kalaktang block were found to be working whereas the solar cookers distributed under the same scheme are not being used by the beneficiaries The only gasifier system installed at a sawmill in Meghalaya was found to be non-functional The detailed state-wise functional status of the systems is as follows

Table 5 1 Status of biomass technologies and IREP schemes under NEC plan (state-wise)

State	Number of systems	No of systems evaluated	to be commissioned	Functional	Non-functional
Arunachal Pradesh	IREP scheme devices 1367	1250	-	1073	177
	Urjagram	Not evaluated			
Assam	Improved Cookstove 80	80		-	80
Manipur	Biogas plant 1	1		0	1
	IC 787	587		0	587
	Energy plantation 3 sites	2 sites		1 site	1 site
Meghalaya	Biogas plant 1	3	1		-
	Wind Mill 1		1		-
	Gasifier 1		-	0	1
Grand Total	2241	1923	2	1074	847

Arunachal Pradesh

Table 5.2 IREP programme of Kalaktang CD block [(NEC (FIN) 1-33/91-92/340, 20.03.1992] Implementing agency. APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/ commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Biogas plant Kalaktang block HQs, Shergaon Thcmbang, and Kamlangch villages 1993	12 6 Functional	Technical specifications Model Deenbandhu Capacity 4 m^3 Benefits/problems • System were constructed for the cooking purpose • Users were not properly trained for daily operation • Irregular feeding of dung and lack of maintenance of the system led to non-functioning of the systems Rectification • Regularise feeding of dung • Cleaning of the choked pipes

Device/system Location Year of installation/ commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar water heater Vivekananda Kendra Vidyalaya Shergaon (2 unit), Tenzingaon hospital (1 unit); Kalaktang hospital (1 unit) 1993	4 Non-functional	Technical specifications Capacity 100 LPD Benefits/problems • Systems were installed to provide hot water to the institutions • Leakage in the collectors of all the systems • Riser pipe damaged due to freezing of water at Vivekananda Kendra Vidyalaya Rectification • To be replaced by new installations
Solar street lights Kalaktang block HQs (6), Forest check gate, Shergaon (2) VK Vidyalaya, Shergaon (3) The location of remainder 12 sites could not be traced. 1993	23 6 Functional	Technical specifications Module 35 Wp, 2 nos. Battery 120 Ah, 12 V Luminarie 11 watts CFL Benefits/Problems • Systems provide lighting for eight hours • Non-functional systems. major problems were with the battery, electronic circuits and luminaries Rectification • Replacement of batteries and electronic circuits
Solar distillation plant Bomdilla (Civil hospital, Public Works Department office) 1993	2 Non-functional	Technical specifications Capacity 2 litre/day Benefits/problems • To provide distilled water for batteries of SPV systems • All systems were dismantled when these became non-functional Rectification • To be replaced by new installations

Device/system Location Year of installation/ commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar lanterns *Different villages in Kalaktang block and block HQs* *1993*	*117* *50% Functional* *(as informed by the local APEDA office)*	*Technical specifications* *Module 18 W* *Luminaire 7 W CFL* *Benefits/problems* • *Lanterns were distributed for lighting* • *Non-functional systems suffered from problems in the circuit and luminaries, subsequently, the batteries were also damaged owing to long periods of non-functioning* *Rectification* • *Repair of damaged parts*
Solar cooker *Kalaktang block HQs* *1993*	*47* *Not being used*	*Technical specifications* *Box type solar cooker with glass cover and four vessels* *Benefits/problems* • *Cookers were distributed for saving fuelwood* • *Cookers were not being used because of insufficient sunlight and not suitable for local cooking practices* *Rectification* • *Discontinue future dissemination of cookers*
Portable improved stoves *Different villages of Kalaktang Block* *1993*	*1000* *900 Functional*	*Technical specifications* *Circular metallic (cast iron) body with legs, grate, approx 18 inches dia ; 12 inches height* *Benefits/problems* • *Suitable for cooking as well as space heating under local conditions* • *High demand for these stoves*
High altitude stoves(bukhari) *Kalaktang block HQs, Bomdila* *1993*	*160* *Functional*	*Technical specifications* *Cylindrical metallic body with chimney, grate, approx 18 inches dia , 24 inches height* *Benefits/problems* • *Suitable for space heating under local conditions* • *High demand for these bukharis*

Device/system Location Year of installation/ commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Aerogenerator Site could not be ascertained 1993	1 Non-functional	Technical specifications Not available Benefits/Problems ▪ Installed for electricity generation Rectification ▪ New installation required
Energy plantation Ankling 1993	1 site Functional	Technical specifications 2 hectare plot planted with gamari (Gmelina arborea) Benefits/Problems ▪ Plantation for fuel and small timber ▪ The State Forest department has acquired part of the plantation

Scheme Setting up of Urjagram [NEC (FIN)/1-25/90-91/36, 19.07 1990], Implemented agency: APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Could not be evaluated because of logistical constraints

Assam

Table 5.3 Electrification of Tarabari village in Kamrup district [NEC (FIN)/ 1-25/92-93/99, 16.03 1993] Implementing agency: Bosco Reach Out, Guwahati

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Improved chulha Tarabari 1993	80 Non functional	Technical specifications Fixed stove (Riagni model) Benefits/Problems ▪ To bring about fuelwood savings

Note Details of the other systems in this scheme are given in Chapter 2 and 4

Manipur

Table 5 4 Scheme for cooking energy need in Manipur
[NEC (FIN) 1-25/88-89/165, 14.03.1989;]
Implementing agency: DSTE (Department of Science, Technology and Environment), Imphal

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/ problems, rectification
Improved chulha Churachandpur dist (2 villages) Ukhrul dist (10 villages) Chandel dist Tamenglong dist (9 villages) 1991	537 Churachandpur- 50 Ukhrul- 250 Chandel- 137 Tamenglong- 100 Non-functional	Technical specifications Fixed chulhas (Grihini model) with and without chimney Benefits/problems ▪ To bring about reduction in fuelwood consumption and smoke in the kitchen ▪ Cookstoves were functional for about two years after installation, ▪ All devices are presently damaged because of lack of maintenance ▪ There is a prevalent demand for chulhas in the study areas Rectification ▪ New devices have to be installed Local populace is willing to share the cost of the cookstoves
Energy plantation Hnathom, Chandel dist., Khongjarun, Tamenlong dist., Singhauli, Churachandpur dist 1991	3 sites Chandel successful Tamenglong site was not visited because of law and order problems (on advice) Churachandpur location of the site could not be ascertained	Technical specifications 1 2 ha plots at each site, planted with eucalyptus and quercus species Benefits/problems ▪ to demonstrate the benefits of fuelwood plantation, and encourage such plantation on a voluntary basis

Table 5 5 Construction cum-training course on biogas plant in Manipur
[NEC (FIN) 1-25/88-89/166, 14.03.1989]
Implementing agency: DSTE (Department of Science, Technology and Environment),Imphal

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Training of masons and construction of biogas plant Iroisemba village, Imphal 1992	1 Non-functional	Technical specifications 1 no.,3 cu m Janata model Benefits/problems ▪ Twenty masons were trained during the construction of the plant ▪ System functioned for one week after installation

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
		▪ Fell into disuse because of improper feeding of dung and lack of training on daily plant operation Rectification ▪ Plant can be revived with repairs, adequate feedstock should be available and regular maintenance of the plant is required.

Table 5.6 Research and development on energy efficient chulha
[NEC (FIN) /1-25/88-89/168, 14.03.1989]
Implementing agency: DSTE (Department of Science Technology & Environment), Imphal

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/ problems, rectification
Molnom village, Ukhrul dist., Molbung village, Senapati dist., Haotah and Thingkangphai village, Churachandpur dist 1992	250 (50 in each village) Thingkangphai village non-functional Remaining sites could not be visited owing to logistical constraints	Technical specifications Portable, fixed (Ghrihini) models Benefits/problems ▪ To bring about savings in fuelwood consumption and smoke in the kitchen ▪ Beneficiaries expressed satisfaction over use of ICs, as these brought about 40% savings in fuelwood use ▪ LPG is now available in the village and surrounding areas and most households (40%) have switched over to LPG

Meghalaya

*Table 5 7 RRE schemes (I) 8 cu m biogas plant, (II) windmill, (III) 2x 500 LDP solar hot water system * [NEC (FIN)/1-25/88-89/74, 22.08.1989,]*
Implementing agency: Ram Krishna Mission Ashram, Cherrapunjee, Meghalaya

Device/System Location, Year of installation	Number of devices Functional status	Technical specifications, benefits/problems, rectification
Biogas plant Ashram campus, Cherrapunjee 1990	1 Not commissioned	Technical specifications Fixed dome (Janata model) Capacity $8m^3$ Benefits/problems ▪ To supply gas for ashram kitchen ▪ Plant was constructed on time but owing to low temperature of the region, it was not commissioned Rectification ▪ Not advisable to revive as local climatic conditions are not suitable for gas production Moreover the cattle population in the ashram is not sufficient to support the plant

Device/System Location Year of installation	Number of devices Functional status	Technical specifications, benefits/problems, rectification
Windmill Ashram campus, Cherrapunjee	1 Not installed	Not available

* For details of the SWHS scheme refer to section Meghalaya, Chapter 3

Table 5.8 100 kW gasifier [NEC (FIN)/1-33/89-90/383, 27.03.1990]
Implementing agency: FDCML (Forest Development Corporation of Meghalaya Limited), Shillong

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/ problems, rectification
Wood based gasifier Darugiri sawmill, village Darugiri, East Garo Hills 1989	1 Non-functional	Technical specifications Alternator 125 kVA, 415 V RPM 1500 Benefits/problems • Wood waste based gasifier was in use as prime-mover for power generation in the saw mill • In October 1990, entire system was submerged in floodwaters, and has remained damaged since then Efforts to rectify by the manufacturer have been unsuccessful Rectification • New system required

6 Energy parks and exhibition vans

Energy parks and mobile exhibition vans are also being sponsored under NEC schemes with the objective of creating awareness among the masses, about the principles of different renewable energy devices and their operation These devices include biogas, improved cookstoves, solar PV devices, windmill, solar water heaters and solar stills. To disseminate information on the benefits of renewable energy technologies (RETs), implementing agencies such as APEDA, ASTEC, MNREDA send the mobile vans to different districts of the respective states, including remote rural areas In the energy parks, working models of various RETs are installed for demonstration

Implementation of energy parks and mobile exhibition vans

Both state nodal agencies and academic institutions in the various states have set up energy parks and procured mobile exhibition vans Five such parks have been established in Arunachal Pradesh (Nirjuli), Assam (Tezpur), Meghalaya (Shillong), Mizoram (Aizawl) and Tripura (Agartala) for awareness generation among the public and also to aid the students and researchers in their academic curriculum In Assam, ASTEC is also setting up a park in Guwahati In Arunachal Pradesh, Assam and Meghalaya, APEDA, ASTEC and MNREDA, respectively have procured exhibition vans for popularisation of RETs

Functional status of energy parks and exhibition vans

The mobile exhibition vans are currently parked in the premises of the implementing agencies, with the exception of ASTEC, which has parked the van in the Regional Science Museum, Guwahati All these vans were acquired from PEDA (Punjab Energy Development Agency), Chandigarh. Almost all the devices installed in the vans are working with exception of few, which can be easily rectified or repaired. Since the devices are only for demonstration purposes, attention towards their maintenance is low

The Energy Park at NERIWALM (North Eastern Regional Institute of Water and Land Management), Tezpur is a successful venture and except for one SPV streetlight, all other systems are functional. The solar panel and the battery of the SPV streetlight, which is not functional, are in working condition The non-

functionality may be due to improper connections and rusting in the joints. The Park in Guwahati encompasses an area of about 3.3 acres donated by the Govt. of Assam. Though ASTEC has procured the devices but these are yet to be installed in the park because of paucity of funds. The Energy Park at St Anthony's college, Shillong was established in 1993, for educational and demonstration purposes. The college management indicated that the renewable energy systems functioned very well for about five years after installation. But owing to lack of funds for maintenance of the systems, most of these are now non-functional. The park in Agartala has also been commissioned and all the installed systems are functioning Some of systems installed at the energy park in Aizawl, Mizoram are non-functional, but can be revived. The detailed state-wise status of the parks and vans is as follows

Table 6.1 Status of energy parks and mobile exhibition vans under NEC plan (state-wise)

Implementing agency	Number of schemes	Scheme evaluated	To be commissioned	Functional	Non-functional
Arunachal Pradesh	2	2		2	
Assam	3	3	1	2	-
Meghalaya	2	2	-	1(partly functional)	1
Mizoram	1	1	-	1 (partly functional)	--
Tripura	2	2		2	-
Grand Total	10	10	1	8	1

Arunachal Pradesh

Table 6.2 Renewable Energy Exhibition Van, Itanagar [NEC (FIN)/1-33/95-96/18, 05 06 95], Implementing agency· APEDA (Arunachal Pradesh Energy Development Agency), Itanagar

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar Photovoltaic battery charger Itanagar 1998	1 Functional	Technical specifications Module 3 nos , 30Wp, 12 V Capacity to charge 12 V batteries for vehicles and other uses This can charge two batteries simultaneously
Solar Photovoltaic Pump Itanagar 1998	1 Functional	Technical specifications Wattage 180W Module 30Wp No battery back-up Capacity, 30 000 litre/day
Biomass gasifier	1	Technical specifications

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Itanagar 1998	Functional	Capacity 3 kW gasifier coupled to diesel generator and a pump (5 hp)
Domestic Solar Drier Itanagar 1998	1 Functional	Technical specifications Capacity 5 kg, with a single collector
Solar still Itanagar 1998	1 Functional	Technical specifications Capacity 4 litres/day Absorber area 1 sq m
Solar Cooker Itanagar 1998	1 Functional	Technical specifications Box type solar cooker with glass cover and four vessels
SPV Street Lighting Itanagar 1998	1 Functional	Technical specifications Module 2 nos, 30 Wp, CFL 11 W Battery 75 Ah, 12 V
SPV operated coloured television set Itanagar 1998	1 Functional	Technical specifications Module 6 nos, 30 Wp Batteries 120 Ah, 12 V
Biogas plant Itanagar 1998	1 Functional	Technical specifications Model metallic floating dome type (prototype) Capacity 0 5 cubic metre
Windmill Itanagar 1998	1 Functional	Technical specifications Not available
Exhibition Hut Itanagar 1998	1 Functional	Technical specifications Lighting Module 2 nos, 30Wp Luminaire 2 nos, 5W CFL Cooking 1 no improved stove (fixed), 1 no biogas stove

Table 6.3 Installation of RRE equipment in NERIST Campus
[NEC (FIN)/1-33/93-94/164, 07.02.94]
Implementing agency: NERIST (North Eastern Regional Institute of Science & Technology), Nirjuli

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
SPV module NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available Benefits/problems • Problems encountered in the gasifier generator
Solar battery NERIST Campus, Nirjuli 1995	8 Functional	Technical specifications Not available
Inverter NERIST Campus 1995	1 Functional	Technical specifications Not available
Luxmeter NERIST Campus, Nirjuli 1995	3 Functional	Technical specifications Not available
Anemometer NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Portable anemometer NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Sunshine recorder NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Wind speed/direction indicator NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Pyranometer NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Biomass gasifier NERIST Campus, Nirjuli 1995	1 Non functional	Technical specifications Not available
Wind mill NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Wind generator NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Solar still NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Solar pumps NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Solar water heater NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Solar cooker NERIST Campus, Nirjuli 1995	1 Functional	Technical specifications Not available
Solarimeter (Suryamapi) NERIST Campus, Nirjuli 1995	3 Functional	Technical specifications Not available

Note All the devices/systems installed are for demonstration purpose to aid the curriculum of the students

Assam

Table 6.4 Setting up of Energy Park at NERIWALM at Tezpur, Assam

[NEC (FIN) 1-33/93-94/ 174, 23.02.1994]

Implementing agency: NERIWALM (North Eastern Regional Institute of Water and Land Mgmt), Tezpur

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar PV pump Dolabari, Tezpur 1996	2 Functional	Technical specifications Wattage 228 Wp Motor 1 submersible and 1 positive displacement Capacity 70 000 litre/day Benefits/problems • Pump water for gardening
Wind pump Dolabari, Tezpur 1996	1 Functional	Technical specifications Operation reciprocating positive displacement Rotor dia. 3 m, lifting head 20 m, pump dia 4 inches Benefits/problems • Pumping water from tubewells

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar hot water system Dolabari, Tezpur 1996	1 Functional	Technical specifications Capacity 50 litres/day Benefits/problems • Can heat and store water at temperature ranging from 55 $^{\circ}$C to 80 $^{\circ}$C
Solar still Dolabari, Tezpur 1996	5 Functional	Technical specifications Capacity 2-3 litres/day Absorber area 1 sq. m
Solar drier Dolabari, Tezpur 1996	1 Functional	Technical specifications Capacity 8-10 kg Temperature attained 60 $^{\circ}$C - 70 $^{\circ}$C
Solar street lights Dolabari, Tezpur 1996	2 1 Functional	Technical specifications Module 2 nos 35 W_p Battery 80 Ah, 12V CFL 11 W (2 nos) Benefits/Problems • Non functional due to the problem in the electronic circuit Rectification • Repairs in the electronic circuit required
Biogas plant Dolabari, Tezpur 1996	1 Functional	Technical specification Model Fixed dome (Deenbandhu) Capacity 2 cumec
Rural house Dolabari, Tezpur 1996	Improved chulha 3 Functional SPV lights 2 Functional B&W television 1 To be installed	Technical specifications Improved chulha Three types of models Grihini without chimney, Pubali without chimney and Sukhad with chimney SPV lighting Module 2 nos , 35 Wp Luminaire 9 W CFL Benefits/problems • For demonstration
Urban house Dolabari, Tezpur 1996	Solar lanterns 6 Functional Solar cooker 1 Functional Solar hot water system 1 Functional Solar UV water purifier 1 Functional	Technical specifications Solar lanterns 18 Wp module and 7 W CFL Solar cooker Box type with four vessels SHWS (prototype) 10 LPD capacity Water purifier 30 Wp module and UV lamp

Device/System Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Biomass gasifier Dolabari Tezpur 1996	1 Functional	Technical specifications Capacity downdraft gasifier (5 kW) coupled to a generator (5 5kVA), 1 no wood chipper (with 1hp motor) Benefits/problems • Provision for electricity generation from the gas
Director's office Dolabari, Tezpur 1996	SPV powered light points 2 Functional Table fan 1 Functional	Technical specifications Module 1 no 35 Wp Luminaire 2 no 7 W CFL Benefits/problems • Provision to operate the lights and fan during non-supply of electricity from the grid
Solar hot water system in Guest-house Dolabari Tezpur 1996	1 Functional	Technical specifications Capacity 500 litre/day (thermo-syphon) Benefits/problems • Provision for hot water for guests

Note With the exception of last two items and solar pump, all RETs installed are for demonstration purposes

Table 6.5 Energy Park in Guwahati [NEC (FIN)/1-33/91-92/377, 24.03.92]

Implementing agency· ASTEC (Assam Science Technology and Environment Council), Guwahati

Device/system	Number of devices	Remarks
1 kW SPV module for lighting	1	
250 LPD Solar hot water heating system	1	
Biogas plants (different models)	2	
Wind pump	1	
Wind battery charger	1	
5 kW gasifier	1	The scheme is yet to be
SPV water pump	1	commissioned by ASTEC
Solar cooker	2	
Improved chulha	10	
Biogas engine (3 HP)	1	
Solar still	2	
Solar drier	1	
Solar greenhouse	1	
Solar passive house	1	
Energy plantation	2 ha	

Table 6.6 Renewable Energy Exhibition Van, Guwahati [NEC (FIN)/1-33/94-95/95, 09.11.94]

Implementing agency: ASTEC (Assam Science Technology and Environment Council), Guwahati

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar photovoltaic battery charger Guwahati 1996	1 Functional	Technical specifications Module 3 nos, 30Wp, 12 V Capacity charging 12 V batteries for vehicles and other uses. It can charge two batteries simultaneously
Solar photovoltaic pump Guwahati 1996	1 Functional	Technical specifications Capacity: 180W Module 30Wp No battery back-up Capacity 30 000 litre/day
Solar water heater Guwahati 1996	1 Functional	Technical specifications Capacity 100 litres/day Design temperature ranging from 55 °C to 80 °C
Biomass gasifier Guwahati 1996	1 Functional	Technical specifications Capacity 5 kWe gasifier coupled to a generator (3 kW) and a pump (5 hp)
Domestic solar drier Guwahati 1996	1 Functional	Technical specifications Capacity 5 kg, with a single collector
Solar still Guwahati 1996	1 Functional	Technical specifications Capacity 2 litres/day Absorber area 1 sq m
Solar cooker Guwahati 1996	1 Functional	Technical specifications Box type solar cooker with glass cover and four vessels
SPV street lighting Guwahati 1996	1 Functional	Technical specifications Module 2 nos, 30 Wp, 12 V Luminaire CFL 11 W Battery 75 Ah, 12 V
SPV operated coloured television set Guwahati 1996	1 Functional	Technical specifications Module 6 nos, 30 Wp Batteries 120 Ah, 12 V
Biogas plant Guwahati 1996	1 Functional	Technical specifications Capacity 0 5 cu m metallic floating dome (Prototype)
Windmill Guwahati 1996	1 Functional	Demonstrates the motive force for water pumping
Exhibition Hut Guwahati 1996	1 Functional	Technical specifications Lighting 2nos SPV domestic lights Module 2 nos, 30Wp, CFL 2 nos, 7W Cooking 1 improved chulha (fixed), 1 biogas stove and 1 lamp

Table 6.8 RRE demonstration in 28 school Science Centre in Assam
[NEC/RRE/282/97-98/54, 27.03.98]
Implementing agency: ASTEC (Assam Science Technology and Environment Council), Guwahati

Scheme yet to be implemented by ASTEC, Guwahati

Meghalaya

Table 6.7 Non-conventional Energy Park at St Anthony's College, Shillong
[NEC (FIN)/1-33/92-93, 06.11.92]
Implementing agency: St Anthony's College, Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar powered television College campus, Shillong 1993	1 Non functional	Technical specifications Module 1 no., 35Wp, 12 V Battery 80 Ah, 12 V Benefits/problems ▪ Module dismantled ▪ Battery missing ▪ Television not available at site Rectification ▪ New installation required
Solar water heater College campus, Shillong 1993	1 Non-functional	Technical specifications Capacity 1000 litres/day, with electrical back-up Benefits/problems ▪ Can heat and store water at temperature ranging from 55 °C to 80 °C ▪ Rusting, choking of pipes, insulation material damaged Rectification ▪ Replacement of connecting pipes, insulation material ▪ General maintenance required
Solar electric fence College campus, Shillong 1993	Not found at site	Technical specifications Not available, system dismantled
Wind pump College campus, Shillong 1993	2 Non-functional	Technical specifications Capacity 1000 litres/day, with electrical back-up Benefits/problems ▪ Provision for water pumping

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
		▪ Rusting and choking of mechanical parts Rectification ▪ Installation of new pump ▪ Cleaning and repair of mechanical parts
Solar powered traffic signal College campus, Shillong 1993	1 Non-functional	Technical specifications Module 1 no., 35Wp, 12 V Battery 80 Ah, 12 V Benefits/problems ▪ Battery damaged Rectification ▪ Replacement of battery, luminaire
Solar powered radio College campus, Shillong 1993	1 Non-functional	Technical specifications Module 1 no , 30Wp, 12 V Battery 40 Ah, 12 V Benefits/problems ▪ Radio not working due to defective battery ▪ Module dismantled Rectification ▪ Replacement of battery
Solar street light College campus, Shillong 1993	5 Functional	Technical specifications Module 5 nos , 30 Wp, CFL 11 W, Battery 75 Ah, 12 V
Solar battery charger College campus, Shillong 1993	1	Technical specifications Module 3 nos , 30Wp, 12 V Benefits/problems Charges 12 V batteries for vehicles and other uses
Solar UV water purifier College campus, Shillong 1993	1 Non-functional	Technical specifications Module 2 nos , 30Wp, UV lamp Battery 75 Ah, 12 V Benefits/problems ▪ After the system developed problems, it was dismantled Rectification ▪ Servicing and repairs of damaged parts
Solar powered insect trap for fish pond College campus, Shillong 1993	1 Functional	Technical specifications Module 1 no , 30Wp Benefits/problems ▪ Insect trap supplies feed for the fish
Solar thermal testing kit	1	Technical specifications

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
College campus, Shillong 1993	Functional	Thermometer, different containers holding various materials Benefits/problems ▪ Demonstration of heat storage capacity of materials

Table 6.8 Mobile Exhibition Van, Shillong [NEC (FIN)/1-33/94-95/86, 20.03.95]

Implementing agency: MNREDA (Meghalaya Non-conventional and Rural Energy Development Agency), Shillong

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar Photovoltaic Battery charger Shillong 1997	1 Functional	Technical specifications Module 2 nos, 30Wp Benefits/problems ▪ Charges 12 V batteries for vehicles and other uses This can charge two batteries simultaneously
Solar Photovoltaic Pump Shillong 1997	1 Functional	Technical specifications Wattage 180W Module 30Wp No battery back-up Benefits/problems ▪ It has a capacity of pumping water at the rate of 30 000 litre/day
Solar Water Heater Shillong 1997	1 Functional	Technical specifications Capacity 50 litres/day Benefits/problems ▪ Can heat and store water at temperature ranging from 55 °C to 80 °C
Biomass Gasifier Shillong 1997	1 Functional	Technical specifications Capacity 5 kW gasifier coupled to diesel generator (3 5kVa) Benefits/problems ▪ Provision for electrical applications of the producer gas
Domestic Solar Drier Shillong 1997	1 Functional	Technical specifications Capacity 5 kg, with a single collector
Solar still Shillong 1997	1 Functional	Technical specifications Capacity 2-3 litres/day Absorber area 1 sq. m

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar Cooker Shillong 1997	1 Functional	Technical specifications Box type solar cooker with glass cover and four vessels
SPV Street Lighting Shillong 1997	1 Functional	Technical specifications Module. 1 nos., 30 Wp, Luminaire: 11 W CFL Battery 75 Ah, 12 V
SPV operated coloured television set Shillong 1997	1 Functional	Technical specifications Module 6 nos, 30 Wp Batteries 120 Ah, 12 V
Biogas plant Shillong 1997	1 Functional	Technical specifications Model metallic floating dome (prototype) Capacity 0 5 cubic metre
Windmill Shillong 1997	1 Functional	Demonstrates the motive force for water pumping
Exhibition Hut Shillong 1997	Solar PV lights 2 Functional IC 1 Functional	Technical specifications Lighting 2 nos. 30Wp module and 2 nos 9 W CFL Cooking 1 no. fixed IC, 1 no biogas stove

Mizoram

Table 6.9 Scheme for establishing Energy Park in Mizoram
[(NEC (FIN)/1-25/92-93/45), 15.12 92]
Implementing agency: Power & Electricity Department, Govt of Mizoram, Aizawl

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems, rectification
Solar photovoltaic pump Aizawl 1995	1 Non functional	Technical specifications Capacity 30 000 litre/day Benefits/problems • Problems in pump Rectification • Repairs required
Solar water heater Aizawl 1995	1 Functional	Technical specifications Capacity 250 litres/day Benefits/problems Can heat and store water at temperature ranging from 65 °C to 80 °C

Device/system Location Year of installation/commissioning	Number of devices Present functional status	Technical specifications, benefits/problems rectification
Biomass gasifier Aizawl 1995	1 Non-functional	Technical specifications Capacity 3 7 kW gasifier Benefits/problems • Provision for thermal /electrical applications • Alternator is not working Rectification • Repair s in alternator required
Solar Cooker Aizawl 1995	1 Functional	Technical specifications Domestic and community sized box type solar cooker with glass cover and vessels
SPV for domestic and public lighting and television Aizawl 1995	2-domestic lights 5- street lights 1- colour television Functional	Technical specifications Luminaire 7 nos, CFL 9/11 W Battery 75 Ah, 12 V
Biogas plant Aizawl 1995	1 Functional	Technical specifications Model KVIC metallic floating dome (prototype)
Wind pump Aizawl 1995	1 Non-functional	Technical specifications Not known Benefits/problems • Problems in pump and rotor Rectification • Pump and rotor can be repaired
Solar refrigerator Aizawl 1995	1 Functional	Technical specifications Module 5 nos, 70 Wp
Wind battery charger Aizawl 1995	1 Non functional	Technical specifications Not available Benefits/problems • Non functional owing to lack of sufficient wind availability
Improved cookstoves Aizawl 1995	Functional	Technical specifications Different models of fixed and portable IC

Tripura

Table 6.10 Energy Park [NEC (FIN) 1-25/93-94/57, 01.03.1994]

Implementing agency: DSTE (Department of Science Technology and Environment), Govt. of Tripura, Agartala (Presently Tripura Renewable Energy Development Agency, Agartala)

Device/system Location Year of installation/commissioning	Number of devices Present functional status *	Technical specifications, benefits/problems, rectification
Centralized SPV powered battery systems for different applications Sukanta Academy, Agartala	20 light points 1 solar fan 1 solar boat 1 solar pump	Technical specifications Battery 6 nos, 6 V, 100 EL Benefits/problems • To provide power for lighting, and operating fan, pump, and boat for demonstration
Solar hot water system Sukanta Academy, Agartala	1	Technical specifications Capacity 100 litres/day
Portable Solar Drier Sukanta Academy, Agartala	1	Technical specifications Not available
Solar Cooker Sukanta Academy, Agartala	1	Technical specifications 1 no box type solar cooker with glass cover and four vessels
Biogas plant Sukanta Academy, Agartala	2	Technical specifications Model Janata, KVIC type Capacity 2 0 cubic metre Benefits/problems • To supply biogas for operating the canteen oven
Improved chulha (IC) Sukanta Academy, Agartala	3	Technical specifications 1 no IC(fixed), 2 nos, portable IC Benefits/problems • To be used in the canteen
Wind tunnel, blower with wind energy device Sukanta Academy, Agartala	1	Technical specifications Not available
Wind battery charger Sukanta Academy, Agartala	1	Technical specifications Capacity 100 W Benefits/problems • For charging batteries
Mini-micro hydel system Sukanta Academy, Agartala	1	Technical specifications Capacity 1 x 125 W
Biomass gasifier Sukanta Academy, Agartala	1	Technical specifications Capacity wood based 3 kW updraft gasifier
Hydram Sukanta Academy, Agartala	1	Technical specifications Size 2 X I inches

Device/system Location Year of installation/commissioning	Number of devices Present functional status *	Technical specifications, benefits/problems, rectification
Solar wind hybrid system Sukanta Academy, Agartala	1	Technical specifications Capacity 200 W Benefits/problems ▪ For operating fountains and music system
Hand pump pedal dynamo Sukanta Academy, Agartala	1	Technical specifications Not available
Hand operated bicycle for handicapped with attached trolley Sukanta Academy, Agartala	1	Technical specifications Not available

* The energy park has been commissioned and functional as reported by the implementing agency vide their letter dated 3 February 2001

Table 6 11 Renewable energy complex [NEC (FIN) 1-33/96-97/215, 14.03.97]

Implementing agency DSTE (Department of Science Technology and Environment,) Govt of Tripura, Agartala (Presently Tripura Renewable Energy Development Agency, Agartala)

Device/system Location Year of installation/commissioning	Number of devices Present functional status*	Technical specifications, benefits/problems, rectification
Renewable energy complex Kalacherra		Technical specifications Not available

* The scheme has been commissioned and functional as reported by the implementing agency vide their letter dated 3 February 2001

7 Conclusion

Implementation of NEC schemes

The renewable energy activities in the Northeastern states are primarily undertaken under the State Plan with support from Ministry of Non-conventional Energy Sources However a large of number of such programmes is supported by the North Eastern Council (NEC) regional plan to supplement the state plans In all the states, nodal agencies comprising state government departments and/ state renewable energy development agencies are responsible for implementation of NEC schemes More recently, non-governmental agencies and academic institutions have also been entrusted with implementation of renewable energy technologies (RETs) in respective states

Under the NEC 's RRE (Rural and Renewable Energy) programme, SPV (solar photovoltaic) schemes account for the largest share of the total schemes sanctioned to the respective states during 1990-1998 These schemes entail the dissemination of SPV systems/devices such as solar lantern, solar domestic lighting systems, street lighting system, power plant, and solar water pumping systems in the region With the exception of Nagaland, all states implemented schemes promoting the use of SPV technology

Solar water heating systems comprise the main application of solar thermal energy in northeastern region State nodal agencies as well as NGOs have implemented such schemes The largest number of solar water heaters has been installed in Manipur in industrial establishments and institutions In Mizoram, solar water heaters have been mostly installed in hospitals

The hydro schemes include the dissemination of watermills and micro hydel systems. The traditional water mills in Arunachal Pradesh were upgraded to modified power production units to enhance the motive power for grinding grain and concurrently generate 1-3 kW of electricity during non-grinding periods. Sixteen micro hydro systems ranging from 10 - 50 kW have been installed in Arunachal Pradesh, Assam, Mizoram and Nagaland for providing electricity at the village level While the State Departments of Power are implementing such schemes, an exception is the micro hydro system installed by an NGO *Bosco Reach Out* in Assam

The respective state nodal agencies are executing biomass and IREP schemes in Arunachal Pradesh, Manipur, Assam and Meghalaya. Technologies such as biogas plants, improved cookstoves, energy plantations and gasifiers have been disseminated under such schemes. For creation of awareness generation among the masses about RETs and to aid the students and researchers in their academic curriculum, state nodal agencies and select academic institutions have set up energy parks and procured mobile exhibition vans.

Functional status of NEC schemes

The present study is a corollary to the recommendation made in TERI's earlier evaluation study of NEC's schemes for concurrent evaluation of the schemes currently under implementation Thus the schemes sanctioned between 1990 and 1998 were evaluated in the seven states of the northeastern region. Out of 60 schemes provided for evaluation, 57 were physically verified for their technical performance and the scope for rectification (Table 7 1) About 12 % of the total sanctioned schemes are yet to be commissioned and are in various stages of implementation. In addition two schemes in Arunachal Pradesh have been partially completed.

Table 7.1 State-wise status of schemes implemented under NEC plan

State	*Scheme sanctioned*	*Scheme evaluated*	*To be commissioned*	*Scheme completed*
Arunachal Pradesh	13	13	2	11 (2 partly completed
Assam	7	7	3	4
Manipur	7	7	-	7
Meghalaya	15	14		15
Mizoram	14	12	1	13
Nagaland	1	1	1	-
Tripura	3	3	-	3
Total	60	57	7	53

Fifty three per cent of the systems evaluated were found to be functional, and about 2 % are yet to be commissioned by the implementing agencies at the time of evaluation (Table 7 2) In Manipur, all the systems under various schemes were found to be non -functional The only exception is a solar water heater installed at an oil expelling unit, which is working since its installation In the other states the performance of the RETs was average, irrespective of the location of the project site. In contrast, most of the schemes sanctioned near Aizawl in Mizoram performed better than those systems installed at remote locations

Table 7.2 Functional status of renewable energy technologies (systems) under NEC plan

Technology	No of systems	No of systems evaluated	To be commissioned	No of systems functional	No of systems non functional
Solar Photovoltaic	3779	3083	92	1613	1378
Solar thermal	26	26	1	9	16
Hydro	29	29	17	6	6
Biomass and IREP	2241	1923	2	1074	847
Energy parks	10	10	1	8	1
Total	6085	5071	113	2710	2248

Despite the extensive dissemination of SPV technology in the region, accounting for more than 60% of the total systems sanctioned under NEC Plan, a large number of SPV systems have been rendered non-functional (45%). This is attributed to problems in the device parts as well as operation and maintenance concerns. While most solar lanterns were found be non-functional because of problems in battery, luminaries and electronics, those in functional state are few because of personal care and maintenance Street lighting systems suffered most because of non-availability of trained persons for maintenance. Solar domestic lighting systems have proved most effective amongst all the SPV devices installed. In Assam, the scheme entailing electrification of nine villages in Sonapur Circle, Kamrup district where 368 DLS were installed, was found to be functional with about 85 % of the DLS in working condition The power plants installed in Meghalaya and Arunachal Pradesh are functional. Solar water purifiers and solar water pumping systems installed in educational institutions suffer from non-functioning of device parts. In addition no expertise was available for maintenance of such systems on site

Of the 26 solar thermal schemes commissioned and evaluated, only nine (35%) systems were found to be functional The major factor responsible for such poor performance is the lack of knowledge of maintenance and operation of such systems. Almost all the non-functional systems suffered from common problems of improper insulation of the pipe, storage tank and choking of solar collectors. However, in Mizoram all the water heating systems installed in hospitals are functional and well maintained. The installation of water heaters in industrial units in Manipur have proved to be an efficient energy saving option bringing about considerable savings in time and fuelwood use.

The upgradation of traditional watermills is a pioneering attempt under the NEC plan aimed at augmenting the motive power for grinding grain as well as generating electrical power. But the technology suffers from limitations for power generation. Out of the 20 sanctioned systems, only 13 were finally

shortlisted, of which only four have been installed. One watermill is out of order and awaits repairs. Hailed as the environment-friendly and cost-effective option for power generation in hilly areas, the micro hydro schemes sanctioned in Arunachal Pradesh, Mizoram, Nagaland and Assam are yet to tap the optimum power potential About 59% of the schemes await commissioning, and out of the completed projects only 20% is functional implying under-utilisation of the systems. Most of the installations suffer from problems related to the design of the civil works, particularly the intake and the power channel. The intake in most of the installations has been washed out unable to withstand the water force during peak periods, indicative of faulty design Further, there is absence of de-siltation chambers in almost all the schemes, leading to reduced capacity of the forebay as well as life of the turbines.

Among the RETs systems evaluated under IREP and biomass schemes, about 56% were functional Almost all the improved cookstoves have exceeded their life or are damaged. However, the users expressed satisfaction over the fuelwood savings brought about by these cookstoves. Biogas plants (one in each state) have performed poorly in Manipur and Meghalaya owing to prolonged disuse of the plants. Those installed at Kalaktang block, Arunachal Pradesh had a functionality rate of 50%. In the same block, solar cookers are not being used by the beneficiaries, as it does not match the local cooking practices. Energy plantations have not been successful as envisaged because of lack of accountability by the implementing agencies The sole gasifier system installed at a sawmill in Meghalaya was functional, till it was damaged by floods and could not be revived.

The mobile exhibition vans and energy parks aimed at creation of awareness generation among the public about RETs, enjoy the highest functional status at 80% This is however attributed to the use of the installed devices for demonstration purposes, being subject to low wear and tear The only exception is St. Anthony's College, Shillong, which maintained its energy park for about five years after installation. But owing to lack of funds for maintenance of the systems, most of these are now non-functional

The implementing agencies apart from successfully disseminating RETs, are also responsible for the maintenance of the systems covered under the RRE schemes Interactions with implementing agencies revealed that maintenance of systems installed is being undertaken regularly at the initial stage i.e. few months after the completion of the scheme. But the monitoring efforts are subsequently reduced or low priority is accorded to maintenance because of lack

of funds and technical manpower The lack of maintenance is mainly due to the remoteness of the project site, lack of availability of the spare parts and frequently occurring operational problems of the systems Although the problems encountered have been minor, and were easily repairable, but because of ignorance of any kind of maintenance guidelines for the users, the rectification was neglected by the users as well as the implementing agencies Thus, systems have been damaged owing to long periods of non-functioning In an attempt to ensure the sustainability of the RETs disseminated, the state renewable energy agency ASTEC, Assam has established village level energy committees to monitor and maintain SPV devices in nine villages of Kamrup district in the state. Monetary contribution collected from the beneficiaries goes towards the employment of a technician for the maintenance of the installed systems This successful initiative has resulted in the high functionality (85%) of the scheme.

In the past, sanction of NEC schemes was largely restricted to state nodal agencies and government departments But from the mid-nineties NEC initiated the move to involve NGOs in the electrification of remote villages through SPV devices Thus SPV schemes were sanctioned to NGOs and academic institutions in Assam, Meghalaya, Arunachal Pradesh and Mizoram However, in the current evaluation, many of the schemes sanctioned to NGOs were found to be non-functional and their implementation has also taken a considerable period compared to state agencies This is attributed to faulty planning and poor maintenance of the systems, resulting from paucity of requisite technical expertise and complete dependence on the supplier/manufacturer for system design, installation and training on operation and maintenance

In spite of the overall low functional status of the schemes implemented, there is scope to revive selected non-functional systems as information on the nature of the defects has been collected during the evaluation process Given the considerable investment made in executing the NEC schemes, it would be a worthwhile exercise to undertake rectification measures (major and minor) so as to revitalise the damaged devices It is suggested that NEC could invite the implementing agencies for a discussion on the functional status of the schemes and the lessons learnt for effective dissemination in their future programmes. Based on the discussions, an assessment of the scale of rectification and its economics can be made, for providing funds by NEC to undertake necessary action in the states.